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(54) Distributed paint manufacturing system

(57) A paint manufacturing method includes receiving each of a group of fluid prepaits at different inputs of a fluid component mixing system, determining at a computer system a first fluid prepaint ratio, and mixing the fluid prepaits in accordance with the first ratio to form a base paint at an output of the mixing system. A paint manufacturing system includes a computer-controlled prepaint mixing system. The prepaint mixing system includes multiple fluid inputs providing for computer-controllable flow of prepaits into the mixing system. The computer system includes a memory storing software instructions that configured the computer system

to receive user input selecting a base paint to be produced, determine a ratio of fluid prepaits needed to produce the base paint, and regulate each fluid flow control to establish, in the determined ratio, a flow of fluid prepaits entering the fluid mixing system. A paint manufacturing system includes multiple paint manufacturing sites that can each produce paint products. Each manufacturing site includes a site control computer to control a paint manufacturing process at the site and the system also includes a coordinating computer system that can exchange manufacturing operations data with each of the site control computers.

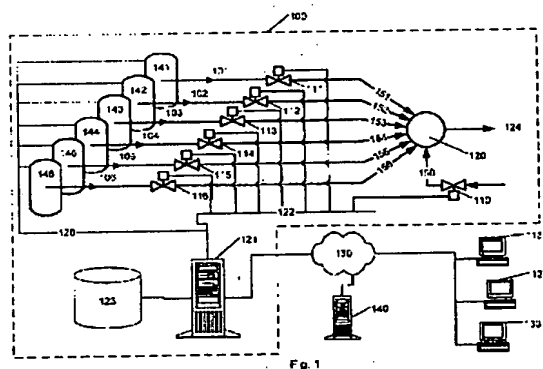


Fig. 1

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Description

BACKGROUND OF THE INVENTION

5 [0001] Paint is a word used to cover a variety of materials such as enamels, lacquers, varnishes, undercoats, surfacers, primers, sealers, fillers, and stoppers. Most paints contain a pigment, a resin polymer which acts as a film-former and binder, to bind the pigment particles together, and a solvent as a diluent. If the pigment is omitted, the paint is referred to as a varnish, sometimes referred to as an enamel, lacquer or topcoat. Lacquers are usually thermoplastic solution paints, whereas enamels are thermosetting paints.

10 [0002] Paint formulating involves the process of selecting the correct paint ingredients in the correct proportions to provide a paint with specific processing and handling properties, as well as the desired final paint properties. The major ingredients of a paint formulation are the binder, the pigment, optional pigment extenders, and water if the paint is a latex paint and solvents if the paint is an oil-based paint. Auxiliary ingredients include defoamers, coalescents, plasticizers, thickeners, non-thickening rheology modifiers, solvents, driers, anti-skinning agents, surfactants, mildewcides, biocides and dispersants. After the paint is formulated and applied to a surface, the paint dries by evaporation of the solvent and/or the water and the binder forms a film containing therein the pigment and the extender particles, if any.

15 [0003] Aqueous-based latex paints are widely used by do-it-yourselfers (DIY) and contractors. They are generally available in four sheens, i.e., gloss, semi-gloss, satin and flat. Sheen selection involves both aesthetic and practical considerations. Different gloss levels can be used to create visual interest as well as help extend the life of the paint. The sheen is determined by the volume of the binder(s), pigment(s), and extender(s), if any, in the paint formulation, as well as the type of binder(s), pigment(s) and extender(s) in the paint formulation.

20 [0004] In addition to the various sheens, paints are formulated to be untinted (white) or tinted to a wide variety of colors using different tint bases, including pastel or light tones, medium or mid-tones, and deep tones. Also, paints are formulated for exterior or interior use. Finally, paints are formulated to provide certain quality performance properties, e.g., good, better and best.

25 [0005] Retailers and manufacturers handle a wide variety of paint products so that the needs of particular users can be met. Paint products may differ in, among other things, sheen, tint base, use type, and quality levels. Sheen types may include (i) gloss, (ii) semigloss, (iii) eggshell, satin, or low luster, and (iv) flat. The number of tint bases depends on the variety of colors being offered and may be on the order of three or four. The use type may include (i) interior use and (ii) exterior use paints. Quality levels may include (i) basic, (ii) improved, and (iii) premium levels. A retailers or manufacturers offering all combinations of these four sheen levels, four tint bases, two use types, and three quality levels would need to handle ninety six different base paints to satisfy customer needs. On the retail level, this requires a large investment in stock and floor space. From a manufacturing perspective, a significant investment in manufacturing plants and equipment may be necessary to offer this large variety of paints. As a result of this large investment, it has been economically necessary to limit paint manufacturing plants to large-scale operations. With respect to large scale paint manufacturing operations, is desirable to reduce manufacturing plant cost so that paint manufacturers can have more flexibility in locating their paint plants. With respect to retail outlets, it is desirable to reduce the variety of paint types that a retail store must stock, while still providing for the various paint types needed by consumers. Consequently, improved paint methods of formulating and manufacturing paint are desired.

SUMMARY OF THE INVENTION

45 [0006] In general, in one aspect, the invention features a paint manufacturing method. The method includes receiving each of a group of fluid prepaints at different inputs of a fluid component mixing system, determining at a computer system a first fluid prepaint ratio, and mixing the fluid prepaints in accordance with the first ratio to form a base paint at an output of the mixing system.

50 [0007] In general, in another aspect, the invention features a paint manufacturing system. The system includes a computer-controlled prepaint mixing system. The prepaint mixing system includes multiple fluid inputs providing for computer-controllable flow of prepaints into the mixing system. The computer system includes a memory storing software instructions that configured the computer system to receive user input selecting a base paint to be produced, to determine a ratio of fluid prepaints needed to produce the base paint, and to regulate each fluid flow control to establish, in the determined ratio, a flow of fluid prepaints entering the fluid mixing system.

55 [0008] Implementations may include one or more of the following features. Base paints produced by the system may be tinted to form colored paints. The system can produce multiple base paints from the fluid prepaints through the combination of the fluid prepaints in accordance with prepaint ratios associated with each of the other base paints. Base paints can have different application characteristics, such as sheen level. The mixing system may be an in-line mixing system that continuously flows fluid prepaints from its inputs to its output. Base paints can be produced without the addition of non-fluid components. In addition to the prepaints, other fluid components, such as water, may be mixed

with the prepaints to form a base paint. Sensor data received at a control computer can be used to indicate a volume of each prepaint entering the mixing system and the computer system can dynamically adjust prepaint flow based on the received sensor data so as to maintain a desired prepaint ratio. The system may use a distributed computer system that includes multiple processing servers and database computers. The system can also include automated purchasing of paint products. To facilitate automated purchasing, the system can process customer orders which can include processing payment transactions by means of data interfaces to consumer credit card, debit card number, and checking account transaction clearing systems. The customer orders may be specified by received data that includes paint quantity and type identifiers. The system may mix paint in accordance with size specified in the customer order. Implementations may be adapted for small-batch (i.e., up to ten gallons) orders that are mixed at a point-of-sale location.

[0009] In general, in another aspect, the invention features a paint manufacturing system. The system includes multiple paint manufacturing sites that can each produce paint products. Each manufacturing site also includes a site control computer to control a paint manufacturing process at the site. The system also includes a coordinating computer system that is can exchange manufacturing operations data with each of the site control computers.

[0010] Implementations may include one or more of the following features. The site control computer can include instructions to control a ratio of manufacturing ingredients combined to produce paint. Exchanging manufacturing operations data can include receiving paint supply data at the coordinating computer system from each of the paint manufacturing sites, and the coordinating computer system can automatically schedule a supply delivery based on the received supply data. Each of the paint manufacturing sites can include a fluid mixing system configured to produce a base paint from a plurality of fluid prepaints and water. The coordinating computer system can be configured to receive customer order data from client computers, process received customer order data, and route the customer order data to one of the paint manufacturing sites. Routing of the customer order data can be based on site capacity data received at the coordinating computer system from the manufacturing sites. The manufacturing sites can include sites configured for small-batch point-of-sale operation.

[0011] The details of one or more embodiments of the invention are set forth in the accompanying drawings and the description below. Implementations may include one or more of the following advantages. Water-resistance, including resistance to blistering, wet adhesion, and scrub resistance of paints prepared using the invention herein may be improved because, among other things, the presence of thickeners in the pigment and extender prepaints, and preferably in the binder prepaints, permits one to use lesser amounts of stabilizing materials. In addition, there should be less viscosity fluctuation in the final paint formulation due to the equilibration of ingredients in the prepaints. Paint manufacturers can produce paint with a reduced ingredients inventory. Retail paint sellers may be able to reduce the paint inventory and/or floor space needed to offer a full line of paint products desired by consumers.

[0012] Other features, objects, and advantages of the invention will be apparent from the description and drawings, and from the claims.

DESCRIPTION OF THE DRAWINGS

[0013] Fig. 1 depicts a paint manufacturing system.

[0014] Fig. 2 is an exemplary user interface screen shot.

[0015] Figs. 3A-3D are exemplary database tables.

[0016] Fig. 4 depicts a distributed paint manufacturing system.

DETAILED DESCRIPTION OF THE INVENTION

[0017] Fig. 1 shows a paint manufacturing system 100 that can be used to manufacture different types of non-reactive base paints from a limited set of fluid prepaints. The system 100 can be adapted for both large-scale and small-scale paint manufacture, as well as paint manufacture at a retail point-of-sale. The system 100 can be used to manufacture a full line of paint products from a limited set of fluid pre-paints. Implementations of the system 100 can, thereby, be used to minimize the number of paint ingredients needed in a paint manufacturer's inventory, and/or to minimize the number of different paint types and retail floor space needed by a vendor selling a full line of paint products.

[0018] In the text that follows, an exemplary implementation in which six different prepaints can be mixed to form ninety-six distinct base paints is described. The different base paints can be distinguished based on their end-use application characteristics. Descriptions of sets of example pre-paints follows the description of the system 100. Implementations may use other numbers of prepaints or may be configured to produce a different number of base paints. In the implementation that is described, base paints are paints to which colorants may be added to form a range of colored paints. That is, base paints are similar to paints commonly provided by manufacturers to retail locations and which are subsequently colored at the retail location in response to a color selection by a customer.

[0019] A base paint's end-use application characteristic are determined by the ratio of the prepaints combined by system 100 to produce the base paint. End-use application characteristics can include visual characteristics such as

paint sheen (e.g., flat, satin, semi-gloss, or gloss), paint application environment (e.g., indoor or outdoor), quality (e.g., basic, improved, or premium), and base tint (e.g., white base, light base, mid-tone base, or deep base). Base tint determines the appearance of a paint when colorants are added to the base paint. A typical manufacturer's consumer paint line may include four different base tints which, by the addition of optional colorants, can provide an extensive palette of colors. These four paint sheens, two application environments, three quality levels, and four base tints, in all their permutations, form a collection of ninety-six base paints ($4 \times 2 \times 3 \times 4 = 96$) having different end-use application characteristics. A large number of colored paints may be formed from each base paint by the addition of colorants.

[0020] The paint manufacturing system 100 includes prepaint fluid inputs 101-106 that are connected by a valve or other adjustable flow control device 111-116 to a fluid mixing system 120. The valves may be pneumatically, hydraulically, magnetically, electrically, or otherwise controlled to moved between different flow positions (e.g., open and closed positions) and are operatively coupled to a computer system 121 by control links 122. The control links 122 can include additional valve control devices and systems. For example, links 122 can include controllers that modulate air pressure through pneumatic lines connected to pneumatic valves. The computer system can individually modulate the valves to control the ratio of preprints 141-146 entering a mixing chamber 120. The ratio of preprints 141-146 entering the mixing chamber 120 determines the composition of the base paint that is formed at an output 124 of the mixing system.

[0021] In some implementations, a feedback signal may be provided from each input valve 111-116 to the computer system to enable more precise control over the volume of each fluid entering the mixing chamber. The feedback signal may be produced by pressure measurement sensors, transit-time flowmeters, flow transducers, and other types of flow sensors. Pressure sensors (e.g., pitot tubes and venturi valves) generate a pressure signal based on pressure changes caused by flowing fluids. The pressure signal can be processed by the computer system to infer fluid flow rates. A transit-time flowmeter can determine fluid flow rates by measuring the effect of a liquid's flow velocity on bi-directional acoustical signals exchanged between an upstream and a downstream transducer. Flow transducer sensors can be used to produce a feedback signal that varies based on movement of a rotor, paddle, or other physical apparatus inserted in the flowing fluid. Other types of fluid flow sensors also can be used. These feedback signals can be sent to computer 121 over the control network 122 or on a separate network. Implementations can also include data connections 128 to sensors and controlled apparatus located in the prepaint storage tanks 141-146. The data connections 128 can be used, e.g., connect volume monitoring sensors in the prepaint tanks so that the computer system 121 can ensure adequate prepaint volumes before a manufacturing operation is initiated. Prepaint temperature and other data may also be collected from sensors in storage tanks 141-146. Data connections 128 also may be used to send control signals to apparatus located in the prepaint storage 141-146. For example, signals may be sent to temperature control apparatus or to a recirculating pump.

[0022] The computer system 121 receives paint selection input data that identifies a base paint to be produced. Paint selection input data may be received by an input device directly coupled to the computer system 121 and/or may be received over a network 130 from one or more client computers 131-133. Fig. 2 shows an example user interface which can be used to receive paint selection input data from a user. Internet-based technologies can be used to implement the user interface 200. For example, user interface 200 may be implemented using a hypertext markup language (HTML) form that is sent from a hypertext transfer protocol (HTTP) enabled computer 121 to a web browser (e.g., Microsoft Internet Explorer®, or Netscape Navigator®) that is executed at a client computer 131-133.

[0023] The interface 200 includes drop-down graphical user interface input controls 211-215 to receive a user's choice of a sheen level 211 (e.g., flat, satin, semi-gloss, gloss), a tint level 212 (e.g., white base, light base, mid-tone base, deep base), a use type 213 (e.g., interior, exterior), a quality level 214 (e.g., basic, improved, premium), and a volume to be produced 215. Implementations can also include special options such as the formulation of extra thick paint 216. Interface 200 includes charts 220 and 240 showing the relative volumes of the preprints (identified by legend 230). In general, the use of such charts 220, 240 would be limited to sophisticated purchasers needing knowledge of particular paint formulations.

[0024] A user interface for do-it-yourself painters (i.e., a user interface used in a retail store or on a general-access web site) may be simplified. For example, charts 220, 240 and legend 230 can be eliminated and, rather than specifying the Tint level (212), the user may identify the color that the base paint is to be colored. Computer 121 can query a database 123 table to determine an appropriate tint level for the selected color. Such a database query may be implemented using a simple database table that includes records associating available colors with tint levels. It should be understood that available software and computer technologies allow a large number of other variations in the interface 200 and a large number of other types of interfaces for the receipt of paint selection input data. For example, a bar code scanner may be used to scan a bar code printed on a paint chip sample card. The data received from the bar code scan may be used to query a paint formulation database.

[0025] After the base paint selection data is received by the computer 121, a formulation of the base paint is determined. The base paint formulation can be determined by querying a database 123. Figs. 3A-3D show portions of an example database table that specifies prepaint formulations used to produce the ninety-six different base paint formulations (i.e., all permutations of the four sheen levels, four base tints, two environmental applications, and three quality

levels of the present exemplary implementation). The database table 3A-3D include ninety-six base paint formulation records (each being a separate row of the database table). Each base paint formulation record includes, among other things, six fields (shown in columns labeled "PP1_Vol", "PP2_Vol", "PP3_Vol", "PP4_Vol", "PP5_Vol", "PP6_Vol") that indicate relative quantities of each pre-paint in a particular base paint.

[0026] Base paint formulation records also can specify other fluids to be added to manufacture a particular base paint. For example, viscosity can be decreased by adding water (relative water quantity is indicated in the "Water_Vol" column) or increased by adding a thickening agent. The system 100 can include one or more fluid valves 110 through which this additional fluids are added. In some implementations, software-implemented algorithms, expert systems, and/or other programmed logic can be used to compute prepaint ratios.

[0027] After computing the ratio of prepaints, the computer system 121 controls prepaint 111-116 valves, and any other fluid 110 flow control valves, and processes feedback signals to control the volume of prepaints and fluids entering a mixing system 120. Implementations can use different types of mixing systems 120 to mix the prepaints and fluids. In an in-line continuous mixing implementation, the prepaints and any other fluids are simultaneously admitted to the mixing system 120 at relative flow rates substantially equal to the relative ratio of the prepaints desired in the final paint product. As the paints flow through the mixing system 120, they are combined in one or more mixing chambers to form a substantially uniform mix of the prepaints. In a simple example, an in-line continuous mixing system 120 can be formed by joining the fluid and prepaint lines 150-156 into a common output line 124. Baffles may be added to the output line 124 or placed in a chamber to help ensure uniform mixing of the fluids and prepaints. Alternatively, the computer system 121 can control the valves 150-156 to sequentially add a measured volume of each prepaint 141-146 to a fixed-capacity mixing chamber 120. When the needed volume of each prepaint is added to the mixing chamber, the prepaints may be agitated to combine them in a uniform mix.

[0028] In a small-batch implementation, the mixing chamber 120 can be a retail paint container (e.g., a quart-sized or gallon-sized paint can) and the system 100 can dispense each of the prepaints directly into the container. The container can then be manually capped and placed in a mixing/agitation machine to uniformly mix the pre-paints. A small-batch implementation may use measurement and dispensing hardware similar to that available in commercial dispensing systems (e.g., a Corob Stratos™ dispensing system or dispensing systems such as those manufactured by Fluid Management® or GSE Dispensing, Inc.). Such hardware can be supplemented by the unique software, data, networking, and prepaint components of system 100.

[0029] System 100 may include automated manufacture of paint products in response to a customer purchase order received at a terminal 131-133. In an Internet-enabled implementation, each terminal 131-133 may be a home computer executing web browser software and connected over a network 130 (e.g., the Internet) to the base paint manufacturing computer system 121. To process request from web browsers at the computers 131-133, the computer system 121 may include web server software that responds to hypertext transfer protocol (HTTP) request from the browsers. The web server software can be a process executed by the computer 121 or by another computer system 140. The web server responds to HTTP request from a web browser by sending hypertext markup language (HTML) data files (also known as web pages) to the browsers. Using web-based technologies, information can be provided to the user from a variety of different data systems 121 and 140 and the users can input data that are provided to different systems 121 and 140. This capability facilitates the implementation of distributed versions of the manufacturing system of Fig. 1.

[0030] Returning again to Fig. 200, a user can enter a paint purchase order by activating a paint purchasing function (e.g., by clicking on the "Place Order" button 251). When the paint purchase function is initiated, data may be sent to an order processing computer 140 which, in turn, results in a purchase order form being returned to the client computer 131-133 and presented to the user. Purchase order data can then be entered at the client computer by a user and returned to the purchase order processing computer 140. The purchase order data may be input using a HTML-based form and can include a quantity of paint being ordered as well as payment information and a selection of a pickup or delivery address. Payment information can include, e.g., a credit card number, a debit card number, an account identifier, or a checking account identifier. Purchase order processing computer 140 may include an interface to a credit clearing computer to process credit card transactions. After the user's payment has cleared, the computer 140 may forward data to the paint manufacturing control computer 121 indicating the type and quantity of paint to produce. Naturally, using conventional computer hardware and software technology, the functions of the purchase order processing computer 140 and paint manufacturing computer 121 and any associated databases can be combined on a single computer or spread over a distributed network of computers and databases.

[0031] Implementations can use a computer system to process customer orders and distribute them among different paint manufacturing sites 100. Fig. 4 shows a distributed manufacturing implementation 400 wherein the order processing computer 140 is coupled over the network 130 to multiple (i.e., five) paint manufacturing sites (shown as blocks labeled 100A to 100E). Each of the paint manufacturing sites 100A to 100E of Fig. 4 can include the data processing and manufacturing equipment shown as included in element 100 of the implementation of Fig. 1. Other elements of Fig. 4 (i.e., network 130, clients 131-133, and order processing computer 140) may be similar to like-numbered elements of Fig. 1.

[0032] Referring to Fig. 4, the order processing computer 140 functions (a "coordinating computer system") can exchange manufacturing data with the manufacturing sites 100-A to 100-E. Manufacturing data can include, among other things, customer order data and the computer system 140 may include functionality to automatically route customer orders to an appropriate manufacturing site 100-A to 100-E. Customer orders may be routed based on the customer's geographic location. A customer may enter a delivery address, zip code, phone number or other identifier associated with a geographic location when placing an order at a client computer 131-133, and the order processing computer 140 can route the order to a manufacturing site 100-A to 100-E based on the location identifier. To route the order, the computer system 140 can query a database mapping the geographic identifier to a particular manufacturing site location. For example, the order processing system 140 may select a retail store at which the paint can be manufactured, route the order to that store, and inform the customer of the store's location. Routing of orders may be based on other factors such as the cost to ship paint from a particular manufacturing site 100-A to 100-E to a final delivery point.

[0033] A manufacturing site 100-A to 100-E can also be selected by the system 140 based on available capacity or on availability of prepaints needed for a particular customer order. For example, the order processing system 140 may receive data from the control computer 121 at each site 100-A to 100-E indicating the amount of spare operating capacity of each of the sites and the volume of prepaints 141-146 at each site 100-A to 100-E. The manufacturing site can then be selected based on available capacity and prepaint supplies. In some cases, the order processing system 140 may determine that no single site has adequate capacity; in such cases, an order may be split among multiple sites. The order processing system 140 may also use capacity data and supply information to automatically schedule deliveries of raw materials, i.e., prepaints, to a site 100-A to 100-E.

[0034] As discussed, the prepaints used in the system 100 are selected so that they can be used to form multiple different base paints. To do so, it is desirable that the prepaints be mutually compatible. Mutually compatible prepaints are those that can be combined without undesirable side effects. In addition, the prepaints may be selected so that they form a non-reactive base paint. As used herein, in a reactive paint, combining the ingredients of the paint initiates a progressive chemical reaction curing the paint. In contrast, in a non-reactive paint, combining the ingredients of the paint does not lead to a rapid progressive chemical reaction curing the paint. Water-based latex paints are an example of a non-reactive paint.

[0035] In some implementations, the base paint manufacturing system 100 may be combined with a system to add colorants directly to the mixing system 120 to produce a final tinted paint product. Alternatively, the output 124 may be coupled to a separate colorant system or the base paint may be put into one-gallon cans, barrels, or other containers and tinted at a later time. Implementations of the system 100 may dynamically change the type of paint being produced. For example, in a small-batch implementation, after producing a gallon of a glossy interior paint, the computer 121 can alter the flow rate of the valves 111-116 so as to set the system 100 to produce a gallon of glossy exterior paint.

[0036] Methods of formulating and selecting prepaints will now be described.

[0037] To formulate prepaints, one needs to consider the range of key properties required by the complete paint line and formulate a set of ingredients (hereinafter referred to as "prepaint") which are capable of being blended in various combinations to cover the key properties required for the particular paint line. The number of prepaints required will depend on how flexible the final matrix of paint needs to be. Specific properties can be improved by adding paint additives which enhance the desired property.

[0038] We have discovered that we are able to achieve this goal by employing a set of N prepaints sufficient to formulate at least 2N different paints, including:

1. at least one fluid prepaint x, including at least one white opacifying pigment;
2. at least one fluid prepaint y, including at least one extender pigment; and
3. at least one fluid prepaint z, including at least one polymeric binder;

wherein N is at least 3, preferable 3-10;

wherein the minimum number of each of prepaint x, y, and z is 1; and

wherein the maximum number of each of prepaint x, y, and z is N-2; and

wherein prepaints x, y, and z are mutually compatible.

[0039] We have also discovered a method of rationalizing the number and types of ingredients to formulate a complete set of paints, including the steps of:

1. providing a set of N prepaints sufficient to formulate at least 2N different paints, including:

- a. at least one fluid prepaint x, including at least one white opacifying pigment;
- b. at least one fluid prepaint y, including at least one extender pigment; and
- c. at least one fluid prepaint z, including at least one polymeric binder;

wherein N is at least 3, preferable 3-10;
 wherein the minimum number of each of prepaint x, y, and z is 1; and
 wherein the maximum number of each of prepaint x, y, and z is N-2; and
 wherein prepaints x, y, and z are mutually compatible;

2. dispensing predetermined amounts of prepaint(s) x, prepaint(s) y, and prepaint(s) z into a container or an application device to form a paint.

[0040] The method may further include the step of mixing prepaint(s) x, prepaint(s) y, and prepaint(s) z before or after they are dispensed into the container or before they are dispensed into the application device.

[0041] The method may further include the step of adjusting the viscosity of dispensed prepaints before or after they are dispensed into the container or before they are dispensed into the application device using thickener, water or a mixture thereof.

[0042] The method may further include the step of adding additional materials that enhance the application or final performance properties of the paint.

[0043] The method may further include the step of adding at least one colorant to the dispensed prepaints.

[0044] The method may be carried out at a paint manufacturing facility, a point-of-sale or at point-of-use and may be controlled by a computer.

[0045] If one key property is varied (for example, sheen level, tint base, use type, or quality type) then the complete set of paints can be made from one each of prepaint x, prepaint y and prepaint z (N=3). The complete set of paints will contain at least 6 paints (2N), preferably 9 paints (3N), more preferably 12 paints (4N) and most preferably 15 paints (5N). If two key properties are varied (for example, two selected from sheen level, tint base, use type, and quality type) then the complete set of paints can be made from at least one each of prepaint x, prepaint y and prepaint z and least one additional prepaint x, y or z (N=4), which depends on which key properties are to be varied. The complete set of paints will contain at least 8 paints (2N), preferably 12 paints (3N), more preferably 16 paints (4N) and most preferably 20 paints (5N).

[0046] If three key properties are varied (for example, three selected from sheen level, tint base, use type, and quality type) then the complete set of paints can be made from at least one each of prepaint x, prepaint y and prepaint z and at least two additional prepaint x, y or z (N=5), which depends on which key properties are to be varied. The complete set of paints will contain at least 10 paints (2N), preferably 15 paints (3N), more preferably 20 paints (4N) and most preferably 25 paints (5N).

[0047] If four key properties are varied (for example, four selected from sheen level, tint base, use type, and quality type) then the complete set of paints can be made from at least one each of prepaint x, prepaint y and prepaint z and at least three additional prepaint x, y or z (N=6), which depends on which key properties are to be varied. The complete set of paints will contain at least 12 paints (2N), preferably 18 paints (3N), more preferably 24 paints (4N) and most preferably 30 paints (5N).

[0048] This technique may be continued to vary as many additional key properties as desired.

[0049] In each of the above examples one is designing the prepaints so that they cover a wide formulation space so that the desired final paint properties lie within the blend space defined with the prepaints at the vertices. In many cases the prepaints will not by themselves be practical paints. But by pushing the prepaints to these extremes one can maximize the blend space available for the system. When the prepaints, additives and colorants are all fully compatible, they can be blended at any ratio without inducing colloidal instability, and one can blend them in any combination needed to achieve the desired paint profile.

[0050] This technique is similar to the design principles used in statistical experimental design and analysis of mixture component designs, however, instead of designing a mixture space to explore the response surface within it, one is designing the boundaries of the mixture space to maximize the flexibility of the paint system. The key to success is to have full compatibility of the individual ingredients and prepaints across the mixture space.

[0051] Paint properties can be predicted in a number of ways. One approach is to develop response surface models of the blend space using standard Mixture Component experimental design statistical tools. These simple statistical models can then be used by a linear optimization program, by a massive grid search or by a graphical analysis tool. Another approach is to simply use empirical methods to determine which blends are needed for specific paint lines, then incorporate those simple empirical recipes in the paint making machine software.

[0052] An extension of the techniques is to have the paint machine automatically pretest certain key properties (e. g., viscosity, forced dry gloss or color) and make minor adjustments during the formulating of the paint from prepaints. Having feedback loops in the paint machine can provide more precise matching of color, gloss, and viscosity targets.

[0053] As used herein, paint ingredients are "compatible" if they can be combined in the various prepaints to provide the desired properties without any negative side effects on other paint ingredients in the prepaint and on the properties that the other ingredients are intended to provide in the final paint. The paint ingredients also have to be compatible

in the final paint which is formulated by mixing the various prepaints. If the prepaints, optional additives included to enhance specific paint properties, and colorants are fully compatible, *i.e.*, they can be blended at any ratio without inducing colloidal instability, then they can be blended in any combination falling within the formulation space needed to achieve the desired property profile in the final paint.

[0054] It is preferred that the all fluid prepaints employed in the method of the invention have the same or similar viscosities to aid in mixing.

[0055] The water-resistance properties, including blister resistance, wet adhesion, and scrub resistance of the final paints prepared by the method of the invention, are expected to be improved because of the use of lower amounts of stabilizing materials such as surfactants. In addition, viscosity fluctuation in the final paint formulation are expected to be reduced because of the equilibration of ingredients in the prepaints.

[0056] The above prepaints are formulated to maximize the flexibility of paint manufacturing. Rather than purchasing individual paint ingredients, paint manufacturers and even buyers at point-of-sale and point-of-use (paint stores, paint departments, contractors and homeowners), can purchase the set of prepaints to prepare a complete set of paints. These sets of prepaints will contain at least one each of prepaints x, y and z and possibly additional variants of each depending upon the formulating flexibility desired. Optionally, the above prepaints are mixed with an additional prepaint which includes at least one colorant, such as a colored pigment or dye.

[0057] The method of the present invention is not limited to preparing only latex paints *per se* but may also be extended to prepare any aqueous coating, or related building product requiring point-of-sale mixing of ingredients, including, sealants, caulks, mastics, adhesives and other building-related products.

[0058] In one embodiment of prepaint x, it is a fluid titanium dioxide prepaint consisting essentially of at least one white opacifying pigment, at least one dispersant, at least one thickener, and water; wherein the dispersant(s) and the thickener(s) are compatible with the pigment(s) and with the other paint ingredients, and wherein the prepaint has a volume solids content of about 30 to about 70%, preferably 35 to 50% and a Stormer viscosity of about 50 to about 250 KU, preferably about 60 to about 150 KU.

[0059] In an alternate embodiment of prepaint x, it is a fluid titanium dioxide prepaint useful for formulating a one pack, pigmented latex paint containing other paint ingredients, which prepaint consists essentially of at least one white opacifying pigment, at least one dispersant, at least one thickener, at least one film-forming or nonfilm-forming polymer, and water; wherein the dispersant(s), the thickener(s), and the polymer(s) are compatible with the pigment(s) and with the other paint ingredients, and wherein the prepaint has a volume solids content of about 30 to about 70%, preferably about 35 to about 50%, a PVC of about 35 to less than 100%, preferably 50 to less than 100%, and a Stormer viscosity of about 50 to about 250 KU, preferably about 60 to 150 KU. Preferably, the polymer is adsorbed onto the white opacifying pigment.

[0060] In one embodiment of prepaint y, it is a fluid pigment extender prepaint which consists essentially of at least one mineral extender, at least one thickener, an optional polymer and water; wherein the pigment extender prepaint has a volume solids content of about 30 to about 70%, preferably about 35 to about 65%, a PVC of about 35 to 100%, preferably about 40 to 100%, and a Stormer viscosity of about 50 to 250 KU, preferably about 60 to about 150 KU; and wherein the prepaint ingredients are compatible with each other and with the ingredients of the other prepaints.

[0061] In one embodiment of prepaint z, it is a fluid polymeric binder prepaint which consists essentially of a water-borne polymeric binder having a Tg of about -30°C to about 70°C, preferably about -10°C to about 60°C, and water; wherein the binder prepaint has a volume solids content of about 25 to about 70%, preferably about 30 to about 65%, and a Brookfield viscosity of less than 100,000 centipoise, preferably about 100 to about 50,000 centipoise, at a shear rate of 1.25 reciprocal seconds; and wherein the prepaint ingredients are compatible with each other and with the ingredients of the other prepaint.

[0062] In the embodiments of prepaints x, y and z, it is possible to have minor amounts, *i.e.*, less than 10% by weight, based on the total weight of the prepaint, of conventional paint additives including acid, base, defoamer, coalescent, cosolvent, mildewcide, biocide, antifreeze agent and the like. These additives must be compatible with the other paint ingredients in the prepaint and the prepaints employed in the method.

[0063] White opacifying pigments useful in the method and prepaint of the invention include white pigments which impart white scattering power to the paint across all visible wave lengths without a high degree of absorption. Pigment extenders are non-settling (without agitation) inorganic solids or opaque polymers which do not impart the primary color or hiding power to the paint although they may have secondary influences on those properties. The tint bases used for deep tone paints typically contain no or only very low levels of white opacifying pigments.

[0064] Suitable white opacifying pigments include titanium dioxide (TiO₂) or a combination of titanium dioxide and auxiliary hiding pigments such as voided latex polymer particles, zinc oxide, lead oxide, a synthetic polymer pigment and mixtures thereof. Rutile and anatase grades of titanium dioxide are suitable for use herein. Rutile titanium dioxide is preferred. The surface of these titanium dioxides may be treated with various organic surface treatments or inorganic surface treatments, *e.g.*, as the oxides of silica, alumina, and zirconia. Fumed titanium oxide is also useful herein.

[0065] The voided latex particles useful in the method of the invention have a particle size diameter of 100 nm to

2,000 nm and a void fraction of 10% to 75%. Preferably, the voided latex particles useful in the method of the invention have a particle size of 500 nm to 1,100 nm. Preferably, the voided latex particles have a single void. The voided latex particles have a glass transition temperature, as measured by differential scanning calorimetry at a rate of 20°C, of at least about 20°C, preferably at least about 50°C. The higher the glass transition temperature, the harder the particle is and less likely it is to collapse. If the voided latex particles collapse, they are unable to contribute to hiding. They may be prepared by conventional polymerization processes known in the art, such as those disclosed in U.S. Patent Nos. 3,784,391, 4,798,691, 4,908,271, and 4,972,000, the disclosures of which are incorporated herein by reference, as well as Japanese Patent Applications, 60/223,873, 61/62510, 61/66710, 61/86941, 62/127336, 62/156387, 01/185311, and 02/140272. Preferably, the voided latex particles are prepared according to U.S. Patent Nos. 4,427,836, 4,469,825, 4,594,363, 4,880,842 and 5,494,971, the disclosure of which are incorporated herein by reference.

[0066] Suitable film-forming or non-film-forming polymers include homopolymers, copolymers or terpolymers selected from the group consisting of acrylic, polyvinyl acetate, styrene-acrylic, styrene-butadiene, vinyl acetate-acrylic, ethylene-vinyl acetate, vinyl acetate-vinyl versatate, vinyl acetate-vinyl maleate, vinyl acetate-vinyl chloride-acrylic, ethylene-vinyl acetate-acrylic and mixtures thereof.

[0067] Extenders pigments useful herein include exterior and interior extender pigments optimized for the intended end use. Exterior extender pigments are not soluble in water, have a low absorption number, and provide tint retention. They are optimized for exterior durability in the particular market where the paint will be sold, are non-cracking, non-chalking, and non dirt retention. They also provide low cost volume. Interior extender pigments are optimized for hiding, gloss, and low cost. Suitable extender pigments include barium sulfate (1-15 microns), Blanc Fixe (0.5-5 microns), calcium carbonate (0.05-35 microns), silica (0.001-14 microns), magnesium silicate (0.5-15 microns), aluminum silicate (0.2-5 microns), mica, bentonite, magnesium aluminosilicate, fumed alumina, colloidal attapulgite, synthetic amorphous sodium aluminosilicate, and sodium potassium aluminosilicate, and the like.

[0068] Binders are polymers or prepolymers which form the primary film of the paint. Binders bind the pigment and/or extenders, provide the required paint flow, and determine the gloss and hardness of the final paint film. The binders selected for the prepaints will depend upon the final use of the formulated paints. Binders suitable for exterior paints are generally suitable for interior paints, but that binders suitable for interior paints may not be suitable for exterior paints.

[0069] Suitable binders include, but are not limited to, film-forming homopolymers, copolymers or terpolymers selected from the group consisting of acrylic, polyvinyl acetate, styrene-acrylic, styrene-butadiene, vinyl acetate-acrylic, ethylene-vinyl acetate, vinyl acetate-vinyl versatate, vinyl acetate-vinyl maleate, vinyl acetate-vinyl chloride-acrylic, ethylene-vinyl acetate-acrylic and mixtures thereof.

[0070] Thickener is a general term which includes any material added to a paint to modify its rheological profile. Preferred thickeners are associative thickeners. Suitable thickeners for use herein include polyvinyl alcohol (PVA); hydrophobically-modified alkali soluble emulsions, known in the art as HASE emulsions; alkali soluble emulsions, known in the art as ASE emulsions; hydrophobically modified ethylene oxide-urethane emulsions known in the art as HEUR emulsions; and cellulosic thickeners such as hydroxy methyl cellulose (HMC), hydroxyethyl cellulose (HEC), hydrophobically-modified hydroxy ethyl cellulose (HMHEC), sodium carboxymethyl cellulose (SCMC), sodium carboxymethyl 2-hydroxyethyl cellulose, 2-hydroxypropyl methyl cellulose, 2-hydroxyethyl methyl cellulose, 2-hydroxybutyl methyl cellulose, 2-hydroxyethyl ethyl cellulose, 2-hydroxypropyl cellulose, and the like. Also useful as thickeners are fumed silica, attapulgite class and other types of clay, titanate chelating agents, and the like.

[0071] Suitable dispersants for use herein include non-ionic, anionic and cationic dispersants such as 2-amino 2-methyl 1-propanol (AMP), dimethyl amino ethanol (DMAE), potassium tripolyphosphate (KTPP), trisodium polyphosphate (TSPP), citric acid and other carboxylic acids, and the like. Anionic polymers such as homopolymers and copolymers based on polycarboxylic acids, including those that have been hydrophobically- or hydrophilically-modified, e.g., polyacrylic acid or polymethacrylic acid or maleic anhydride with various monomers such as styrene, methacrylate, diisobutylene, and other hydrophilic or hydrophobic comonomers are also suitable for use as dispersants.

[0072] Suitable defoamers include silicone-based and mineral oil-based defoamers, and the like.

[0073] Coalescents are not necessary if solvent-free polymeric binders are used in the binder prepaints. Solvent-free binders typically have a low Tg and low minimum film-forming temperature. If a coalescent is required, part of the water in the binder prepaints is replaced with the coalescent.

[0074] Suitable solvents include ethylene glycol, propylene glycol, hexylene glycol, 2,2,4-trimethyl-1,3-pentanediol monoisobutyrate (TEXANOL), glycol ethers, mineral spirits, methyl carbitol, butyl carbitol, phthalates, adipates, and the like.

[0075] Suitable mildewcides and biocides include zinc oxide, isothiazolones, triazoles, and the like.

[0076] Suitable surfactants include cationic, anionic, and non-ionic surfactants.

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EXAMPLES

Test Procedures

[0077] The Stormer viscosity of the prepaints is measured using ASTM method D562.

[0078] The Brookfield viscosity of the binder prepaints and final paints is measured using spindle #4 of a Brookfield viscometer at 6 rpm.

[0079] The ICI viscosity of the prepaints and paints is measured using ASTM method D3205-77.

Example 1

[0080] This example describes the preparation of a white prepaint which was prepared by combining the following ingredients:

Ingredient	Amount (lbs./100 gallons)
Pigment - Titanium Dioxide Slurry (76.5% solids) (Ti-Pure R-746 -- DuPont)	1152.25
Dispersant (Tamol 1124 - Rohm & Haas)	7.06
Defoamer (Drewplus L-475)	1.00
Binder Acrylic (50% solids - Tg 28 °C) (Rhoplex SG - 10M - Rohm & Haas)	166.32
Opacifier - Voided Latex Particles (Ropaque® OP-96 - Rohm & Haas)	151.80
Coalescent (Texanol)	12.95
Rheology Modifier (Acrysol RM-8W- Rohm & Haas)	12.76
Base - Ammonia (28%)	1.65

[0081] The prepaint was prepared using a laboratory mixer having a 45° pitch stirring blade. The water, dispersant, and defoamer, were combined and mixed. The titanium dioxide slurry was slowly added and the mixture was stirred for 15-20 minutes. The binder, coalescent, rheology modifier, ammonia, and additional water, if necessary, were then added.

[0082] The resulting prepaint had a total volume of 100 gallons, a total weight of 1,505.80 lbs., a total PVC of 80.00%, a volume solids of 44.00%, a weight solids of 67.14%, a density of 15.0580 lbs./gallon, 0.40% dispersant on pigment solids, and 10.00% coalescent on latex solids. Its initial and equilibrated Stormer viscosities were 88 and 90 KU. Its initial and equilibrated pH values were 8.8 and 8.6.

Example 2

[0083] This example describes the preparation of an exterior pigment extender prepaint. It was prepared as above by combining the following ingredients:

Ingredient	Amount (lbs./100 gallons)
Pigment - Nephilene Syenite (7.5μ) (Minex 4)	784.30
Dispersant (Tamol 1124 - Rohm & Haas)	7.84
Defoamer (Drewplus L-475)	2.00
Binder Acrylic (53.5% solids - Tg 18 °C) (Rhoplex ML-200 - Rohm & Haas)	157.49

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(continued)

Ingredient	Amount (lbs./100 gallons)
Coalescent (Texanol)	5.90
Rheology Modifier (Acrysol RM-8W - Rohm & Haas)	2.55
Water	368.86

[0084] The resulting prepaint had a total volume of 100 gallons, a total weight of 1,328.94 lbs., a total PVC of 80.00%, volume solids of 45.00%, a weight solids of 65.36%, a density of 13.2894 lbs./gallon, 0.50% total dispersant on pigment solids and 7.00% total coalescent on binder solids. The initial and equilibrated Stormer viscosities were 90 and 93. The initial and equilibrated pH values were 8.9 and 8.7.

Example 3

[0085] This example describes the preparation of an interior pigment extender prepaint which was prepared as described above by combining the following ingredients:

Ingredient	Amount (lbs./100 gallons)
Pigment - Calcium Carbonate (12 μ) (Omyacarb 12)	405.67
Pigment - Calcium Carbonate (3.2 μ) (Vicron 15-15)	203.59
Pigment - Aluminum Silicate (1.4 μ) (Optiwhite)	165.41
Dispersant (Tamol 1124 -Rohm & Haas)	7.75
Defoamer (Drewplus L-475)	1.00
Binder - Vinyl Acetate/Acrylic (55% solids - Tg 14 °C) (RES 3803)	157.61
Coalescent (Texanol)	6.07
Rheology Modifier - HEUR (Acrysol RM-2020-NPR)	17.53
Base - Ammonia (28%)	0.87
Water	356.59

[0086] The resulting prepaint had a total volume of 100 gallons, a total weight of 1,322.09 lbs., a total PVC of 80%, a volume solids of 45%, a weight solids of 65.15%, a density of 13.2210 lbs./gallon, 0.50% dispersant on pigment solids, and 7.00% coalescent on binder solids. Its initial and equilibrated Stormer viscosities were 94 and 97. Its initial and equilibrated pH values were both 9.2.

Example 4

[0087] This example describes of a vinyl acetate/acrylic binder prepaint was prepared as described above except that the binder, defoamer, coalescent, ammonia, water, and rheology modifier were combined and mixed. The ingredients and amounts were as follows:

Ingredient	Amount (lbs./100 gallons)
Defoamer (Drewplus L-475)	8.00
Binder - Vinyl Acetate/Acrylic (55% solids - Tg 14 °C) (RES 3803)	788.06

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(continued)

Ingredient	Amount (lbs./100 gallons)
Coalescent (Texanol)	30.34
Rheology Modifier -HEUR (Acrysol SCT-275 - Rohm & Haas)	3.02
Base - Ammonia (28%)	1.95
Water	60.08

[0088] The resulting prepaint had a total volume of 100 gallons, a total weight of 891.45 lbs., a volume solids of 45.00%, a weight solids of 48.62%, a density of 8.9144 lbs./gallon and 7.00% coalescent on binder solids. Its initial and equilibrated Stormer viscosities were 88 and 90. Its initial and equilibrated pH values were 8.6 and 8.4. Its equilibrated Brookfield viscosity should be less than 10,000 cps.

Example 5

[0089] This example describes a flat acrylic binder prepaint which prepaint was prepared as above by combining the following ingredients:

Ingredient	Amount (lbs./100 gallons)
Defoamer (Drewplus L-475)	8.00
Binder - Acrylic (53.5% solids - Tg 18°C) (Rhoplex ML-200 - Rohm & Haas)	769.96
Coalescent (Texanol)	28.83
Rheology Modifier (HEUR) (Acrysol RM-8W - Rohm & Haas)	1.15
Base - Ammonia (28%)	.57
Solvent - Propylene Glycol	60.00
Water	12.84

[0090] The resulting prepaint had a total volume of 100 gallons, a total weight of 881.35 lbs., a volume solids of 44.00%, a weight solids of 46.74%, a density of 8.8133 lbs./gallon, and 7.00% coalescent on binder solids. Its initial and equilibrated Stormer viscosities were 91 and 89. Its initial and final pH values were both 8.9/9.0. Its equilibrated Brookfield viscosity should be less than 10,000 cps.

Example 6

[0091] This example describes a gloss acrylic binder prepaint which prepaint was prepared as described above by combining the following ingredients:

Ingredient	Amount (lbs./100 gallons)
Defoamer (Drewplus L-475)	8.00
Binder - Acrylic (50% solids - Tg 28°C) (Rhoplex SG-10M - Rohm & Haas)	737.08
Coalescent (Texanol)	36.85
Rheology Modifier - HEUR (Acrysol - RM 8W - Rohm & Haas)	11.62
Base - Ammonia (28%)	.35

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(continued)

Ingredient	Amount (lbs./100 gallons)
Solvent - Propylene Glycol	60.00
Water	21.26

[0092] The resulting prepaint had a total volume of 100 gallons, a total weight of 875.16 lbs., a volume solids of 39.00%, a weight solids of 42.11%, a density of 8.7519 lbs./gallon and 10.00% coalescent on binder solids. Its initial and equilibrated Stormer viscosities were 97 and 98. The initial and equilibrated pH values were 9.0. Its equilibrated Brookfield viscosity should be less than 10,000 cps.

Example 7

[0093] This example describes the preparation of a white pigment prepaint prepared with a solvent-free acrylic binder and without the use of a coalescent. The ingredients are mixed as described in Example 1 using the ingredients and amounts set out below.

Ingredient	Amount (lbs./100 gallons)
Pigment -Titanium Dioxide (Ti-Pure R-706 - DuPont)	734.49
Opacifier - Voided Latex Particles (Ropaque® OP-96 - Rohm & Haas)	164.43
Dispersant (Tamol 731 - Rohm & Haas)	29.38
Non-ionic Surfactant (Triton CF-10)	2.00
Biocide (Kathon LX (1.5%) - Rohm & Haas)	2.00
Defoamer (Foamaster VL)	3.00
Binder - Acrylic copolymer (43.5% solids - Tg -2 °C) (Rhoplex SF-012 - Rohm & Haas)	165.96
Rheology Modifier - HEUR (Acrysol RM-825 - Rohm & Haas)	5.00
Rheology Modifier - HEUR (Acrysol RM-2020 NPR - Rohm & Haas)	42.69
Base - Ammonia (28%)	.49
Water	250.13

[0094] The resulting prepaint should have a total volume of 100.00 gallons, total weight of 1,401.34 lbs., total PVC of 80.00%, volume solids of 40.00%, weight solids of 61.09% density of 14.0134 lbs./gallon, and 1.00% dispersant on pigment solids. Its estimated Stormer viscosity is 102 KU. Its pH should be 8.5 - 9.0.

Example 8

[0095] This example describes the preparation of an exterior pigment extender prepaint with a solvent-free acrylic binder without the use of a coalescent. The ingredients are mixed as described in Example 1 using the ingredient amounts set out below.

Ingredient	Amount (lbs./100 gallons)
Pigment — Nephiline Syenite (7.5μ) (Minex 4)	697.16
Dispersant	27.89

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(continued)

Ingredient	Amount (lbs./100 gallons)
(Tamol 731 - Rohm & Haas)	
Non-ionic Surfactant (Triton CF-10)	2.00
Biocide (Kathon LX (1.5%) - Rohm & Haas)	2.00
Defoamer (Foamaster VL)	3.00
Binder - Acrylic (46.5% solids - Tg 1 °C) (Primal SF-015 Rohm & Haas)	160.84
Rheology Modifier HEUR (Acrysol RM-2020 NPR - Rohm & Haas)	101.80
Water	284.47

[0096] The resulting prepaint should have a total volume of 100 gallons, a total weight of 1,280.91 lbs., total PVC of 80.00%, volume solids of 40.00%, weight solids of 60.27%, density of 12.8089 lbs./gallon, and 1.00% dispersant on pigment solids. Its Stormer viscosity should be 95 KU. Its pH should be 8.5 - 9.0. If not, the pH is adjusted as described in Example 7.

Example 9

[0097] This example describes the preparation of an interior pigment extender prepaint prepared with a solvent-free vinyl acetate/acrylic binder without the use of a coalescent. The ingredients are mixed as described in Example 1 using the ingredient amounts set out below.

Ingredient	Amount (lbs./100 gallons)
Pigment - Calcium Carbonate (3.2μ) (Snowflake)	451.20
Pigment - Aluminum Silicate (1.4μ) (Optiwhite)	220.37
Dispersant (Tamol 1254 - Rohm & Haas)	19.19
Non-ionic Surfactant (Triton CF-10)	2.00
Biocide (Kathon LX (1.5%))	2.00
Defoamer (Foamaster VL)	3.00
Binder- Vinyl Acetate/Acrylic (55% solids) (Rovace 9900)	139.86
Rheology Modifier HASE (Acrysol DR-3)	9.00
Base -- Ammonia (28%)	0.86
Water	405.69

[0098] The resulting prepaint should have a total volume of 100 gallons, a total weight of 1,254.91 lbs., total PVC of 80.00%, a volume solids of 40.00%, a weight solids of 59.65%, a density of 12.5489 lbs./gallon, and 1.00% dispersant on pigment solids. Its Stormer viscosity should be 95 KU. Its pH should be 8.5 - 9.0.

Example 10

[0099] This example describes the preparation of a vinyl acetate/acrylic binder prepaint prepared with a solvent-free

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vinyl acetate/acrylic binder without a coalescent. The ingredients are mixed as described in Example 4 using the ingredient amounts set out below.

Ingredient	Amount (lbs./100 gallons)
Binder - Vinyl Acetate/Acrylic (55% solids - Tg 10 °C) (Rovace 9900 - Rohm & Haas)	699.25
Defoamer (Foamaster VL)	3.00
Rheology Modifier HASE (Acrysol DR-3 - Rohm & Haas)	12.96
Base -Ammonia (28%)	2.90
Water	405.69

[0100] The resulting prepaint should have a total volume of 100 gallons, a total weight of 885.16 lbs., a volume solids of 40.00%, a weight solids of 43.45%, and a density of 8.8516 lbs./gallon. Its Stormer viscosity should be 99 KU. Its Brookfield viscosity should be less than 10,000 cps. Its pH should be 8.5-9.0.

Example 11

[0101] This example describes the preparation of a flat binder prepaint prepared with a solvent-free acrylic binder and no coalescent. The ingredients are mixed as described in Example 4 using the ingredient amounts set out below.

Ingredient	Amount (lbs./100 gallons)
Defoamer (Foamaster VL)	8.00
Binder - Acrylic Copolymer (43.5% solids - Tg -2 °C) (Rhoplex SF-012 - Rohm & Haas)	723.77
Rheology Modifier - HEUR (Acrysol RM -2020 NPR - Rohm & Haas)	3.00
Water	133.75

[0102] The resulting prepaint should have a total volume of 100 gallons, a total weight of 868.52, a volume solids of 36.00%, a weight solids of 38.75% and a density of 8.6853 lbs./gallon. Its Stormer viscosity should be 99 KU. Its Brookfield viscosity should be less than 10,000 cps. Its pH should be 8.5 - 9.0 and, if not, it is adjusted as discussed above.

Example 12

[0103] This example describes the preparation of a gloss binder prepaint using a solvent-free acrylic binder and no coalescent. The ingredients are mixed as described in Example 4 using the ingredient amounts set out below.

Ingredient	Amount (lbs./100 gallons)
Defoamer (Foamaster VL)	8.00
Binder - Acrylic Copolymer (43.5% solids - Tg -2 °C) (Rhoplex SF-012 - Rohm & Haas)	767.57
Rheology Modifier - HEUR (Acrysol RM-2020 NPR - Rohm & Haas)	23.00
Water	61.62

[0104] The resulting prepaint should have a total volume of 100.00 gallons, a total weight of 860.40 lbs., a volume solids of 37.00%, a weight solids of 38.81% and a density of 8.6040 lbs./gallon. Its Stormer viscosity should be 99 KU. Its Brookfield viscosity should be less than 10,000 cps. Its pH should be 8.5 - 9.0 and, if not, it should be adjusted as

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described above.

Exempl 13

- 5 [0105] This example describes the preparation of a white pigment prepaint using an interior gloss grade titanium dioxide which is prepared by combining the following ingredients:

Ingredient	Amount (lbs./100 gallons)
Pigment -Titanium Dioxide (Ti-Pure R-900 - DuPont)	734.49
Opacifier - Voided Latex Particles (30.5% solids) (Ropaque® Ultra-Rohm & Haas)	164.43
Dispersant (Tamol 1254 - Rohm & Haas)	20.99
Non-ionic Surfactant (Triton CF-10)	2.00
Biocide (Kathon LX (1.5%) - Rohm & Haas)	2.00
Defoamer (Foamaster VL - source)	3.00
Binder - Vinyl Acetate/Acrylic (55% solids - Tg 14 °C) (RES 3083 - Rohm & Haas)	140.10
Coalescent (Texanol)	11.37
Rheology Modifier)HASE (Acrysol DF3-source?)	11.47
Base - Ammonia (28%)	1.20
Solvent - Propylene Glycol	50.00
Water	264.38

- 35 [0106] The resulting prepaint had a total volume of 100 gallons, a total weight of 1405.43 lbs., a total PVC of 80%, a volume solids of 40%, a weight solids of 61.25%, a density of 14.0543 lbs./gallon, 1.00% dispersant on pigment solids, and 9.00% coalescent on binder solids. The Stormer viscosity was 100 KU. The Brookfield viscosity was 15,300 cps. The pH was 8.8.

Example 14

- 40 [0107] This example describes the preparation of a white pigment prepaint using an exterior gloss grade titanium dioxide which is prepared by combining the following ingredients:

Ingredient	Amount (lbs./100 gallons)
Pigment -Titanium Dioxide (Ti-Pure® R-706-DuPont)	734.56
Opacifier - Voided Latex Particles (30.5% solids) (Ropaque® Ultra-Rohm & Haas)	164.44
Dispersant (Tamol 731- Rohm & Haas))	29.38
Non-ionic Surfactant (Triton CF-10)	2.00
Biocide (Kathon LX (1.5%) - Rohm & Haas)	2.00
Defoamer (Foamaster VL)	3.00

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(continued)

Ingredient	Amount (lbs./100 gallons)
Binder - Acrylic Copolymer (50% solids - Tg 28 °C) (Rhoplex SG-10 - Rohm & Haas)	151.20
Coalescent (Texanol)	12.49
Rheology Modifier (HEUR) (Acrysol RM-2020 NPR - Rohm & Haas)	42.69
Base - Ammonia (28%)	49
Solvent - Propylene Glycol	50.00
Water	211.34

[0108] The resulting prepaint had a total volume of 100 gallons, a total weight of 1403.61 lbs., a total PVC of 80%, a volume solids of 40%, a weight solids of 61.23%, a density of 14.0361 lbs./gallon, 1.00% dispersant on pigment solids, and 9.00% coalescent on binder solids. The Stormer viscosity was 100 KU. The Brookfield viscosity was 4,010 cps. The pH was 8.8.

Example 15

[0109] This example describes the preparation of an exterior pigment extender prepaint. It is prepared by combining the following ingredients:

Ingredient	Amount (lbs./100 gallons)
Pigment - Nephilene Syenite (7.5μ) (Minex 4)	697.16
Dispersant (Tamol 731 -Rohm and Haas)	27.89
Non-ionic Surfactant (Triton CF-10)	2.00
Biocide	2.00
Kathon LX (1.5%) -- Rohm & Haas)	3.00
Defoamer (Foamaster VL)	139.98
Binder - Acrylic (53.5% solids — Tg 18 °C) (Rhoplex Multilobe 200 - Rohm & Haas)	5.24
Coalescent (Texanol)	101.80
Rheology Modifier - HEUR (Acrysol RM - 2020 - Rohm & Haas)	50.00
Solvent -Propylene Glycol	254.40
Water	

[0110] The resulting prepaint had a total volume of 100 gallons, a total weight of 1281.47 lbs., a total PVC of 80.00%, a volume solids of 40.00%, a weight solids of 60.25%, a density of 12.8143 lbs./gallon, 1.00% dispersant on pigment solids, and 7.00% total coalescent on binder solids. The Stormer viscosity was 96 KU. The Brookfield viscosity was 7,210 cps. The pH was 9.8.

Example 16

[0111] This example describes the preparation of an interior pigment extender prepaint. It is prepared by combining the following ingredients:

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Ingredients	Amounts (lbs./100 gallons)
Pigment - Calcium Carbonate (5 μ) (Snowflake)	451.20
Pigment - Aluminum Silicate (1.4 μ) (Optiwhite)	220.37
Dispersant (Tamol 1254 - Rohm & Haas)	19.19
Non-ionic Surfactant (Triton CF-10)	2.00
Biocide (Kalthon LX (1.5%) - Rohm & Haas)	2.00
Defoamer (Foamaster VL)	3.00
Binder - Vinyl Acetate/Acrylic (55% solids - Tg 14 °C) (RES 3083 - Rohm & Haas)	140.10
Coalescent (Texanol)	6.93
Rheology Modifier - HASE (Acrysol DR-3 - Rohm & Haas)	11.00
Base - Ammonia (28%)	0.86
Solvent - Propylene Glycol	50.00
Water	348.48

[0112] The resulting prepaint had a total volume of 100 gallons, a total weight of 1255.13 lbs., a total PVC of 80.00%, a volume solids of 40.00%, a weight solids of 59.65%, a density of 12.5512 lbs./gallon, 1.00% dispersant on pigment solids, and 9.00% total coalescent on binder solids. The Stormer viscosity was 102 KU. The Brookfield viscosity was 3,410 cps. The pH was 8.9.

Example 17

[0113] This describes the preparation of a vinyl acetate/acrylic binder prepaint. It is prepared by combining the following ingredients:

Ingredients	Amounts (lbs./100 gallons)
Defoamer (Foamaster VL)	3.00
Binder - Vinyl Acetate/Acrylic (55% solids - Tg 14 °C) (RES 3083 - Rohm & Haas)	700.48
Coalescent (Texanol)	34.67
Rheology Modifier - HASE (Acrysol DR-3 - Rohm & Haas)	12.96
Base - Ammonia (28%)	2.90
Solvent - Propylene Glycol	50.00
Water	83.48

[0114] The resulting prepaint had a total volume of 100 gallons, a total weight of 887.49 lbs., a volume solids of 40.00%, a weight solids of 43.41%, a density of 8.8750 lbs./gallon, 9.00% coalescent on binder solids. Its Stormer viscosity was 98.0. The Brookfield viscosity was 13,600 cps. Its pH was 9.0.

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Example 18

[0115] This example describes the preparation of a flat acrylic binder prepaint. It is prepared by combining the following ingredients:

Ingredients	Amounts (lbs./100 gallons)
Defoamer (Foamaster VL)	3.00
Binder - Acrylic (53.5% solids - Tg 18 °C) (Rhoplex Multilobe 200 - Rohm & Haas?)	699.92
Coalescent (Texanol)	26.21
Rheology Modifier - HEUR (Acrysol RM-2020 NPR - Rohm & Haas)	1.44
Base - Ammonia (28%)	0.35
Solvent - Propylene Glycol	50.00
Water	96.59

[0116] The resulting prepaint had a total volume of 100 gallons, a total weight of 877.51 lbs., a volume solids of 40.00%, a weight solids of 42.67%, a density of 8.7751 lbs./gallon, 7.00% coalescent on binder solids. Its Stormer viscosity was 94.0. The Brookfield viscosity was 4,900 cps. Its pH was 8.9.

Example 19

[0117] This example describes the preparation of a gloss acrylic binder prepaint. It is prepared by combining the following ingredients:

Ingredients	Amounts (lbs./100 gallons)
Defoamer (Foamaster VL)	3.00
Binder - Acrylic Copolymer (50% solids - Tg 28 °C) (Rhoplex SG-10M - Rohm & Haas)	755.99
Coalescent (Texanol)	37.80
Rheology Modifier - HEUR (Acrysol RM-2020 NPR - Rohm & Haas)	11.62
Base - Ammonia (28%)	0.35
Solvent - Propylene Glycol	50.00
Water	17.68

[0118] The resulting prepaint had a total volume of 100 gallons, a total weight of 876.44 lbs., a volume solids of 40.00%, a weight solids of 43.13%, a density of 8.7644 lbs./gallon, 10.00% coalescent on binder solids. Its Stormer viscosity was 96. The Brookfield viscosity was 5,000 cps. Its pH was 8.8.

Example 20

[0119] This example describes the preparation of a white prepaint by combining the following ingredients:

Ingredient	Amount (lbs./100 gallons)
Pigment - Titanium Dioxide (Ti-Pure R-706 -- DuPont)	1001.66
Dispersant (Tamol 1124 - Rohm & Haas)	20.03

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(continued)

Ingredient	Amount (lbs./100 gallons)
Defoamer (Drewplus L-475)	1.00
Binder Acrylic (50% solids - Tg 28 °C (Rhoplex SG - 10M - Rohm & Haas)	189.00
Opacifier - Voided Latex Particles (Ropaque® OP-96 - Rohm & Haas)	172.50
Coalescent (Texanol)	14.72
Rheology Modifier (Acrysol RM-8W - Rohm & Haas)	2.00
Base - Ammonia (28%)	1.65
Water 200.44	200.44

[0120] The resulting prepaint should have a total volume of 100 gallons, a total weight of 1,602.99 lbs., a total PVC of 80.00%, a volume solids of 50.00%, a weight solids of 71.66%, a density of 16.03 lbs./gallon, 1% dispersant on pigment solids, and 10.00% coalescent on latex solids.

Example 21

[0121] This example describes the preparation of an exterior pigment extender by combining the following ingredients:

Ingredient	Amount (lbs./100 gallons)
Pigment - Nephilene Syenite (7.5μ) (Minex 4)	871.44
Dispersant (Tamol 1124 - Rohm & Haas)	8.71
Defoamer (Drewplus L-475)	2.00
Binder Acrylic (60.5% solids - Tg 16 °C) (Rhoplex AC-264 - Rohm & Haas)	154.74
Coalescent (Texanol)	6.56
Rheology Modifier (Acrysol RM-8W - Rohm & Haas)	3.00
Water	326.08

[0122] The resulting prepaint should have a total volume of 100 gallons, a total weight of 1,382.53 lbs., a total PVC of 80.00%, a volume solids of 50.00%, a weight solids of 69.80%, a density of 13.82 lbs./gallon, 0.5% dispersant on pigment solids, and 7.00% coalescent on latex solids.

Example 22

[0123] This example describes the preparation of an interior pigment extender prepaint by combining the following ingredients:

Ingredient	Amount (lbs./100 gallons)
Pigment - Calcium Carbonate (12μ) (Omyacarb 12)	450.67
Pigment - Calcium Carbonate (3.2μ)	226.17

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(continued)

Ingredient	Amount (lbs./100 gallons)
(Vicron 15-15)	
Pigment - Aluminum Silicate (1.4 μ)	183.76
(Optiwhite)	
Dispersant	8.61
(Tamol 1124 -Rohm & Haas)	
Defoamer	1.00
(Drewplus L-475)	
Binder - Vinyl Acetate/Acrylic (55% solids - Tg 14 °C)	175.09
(RES 3803)	
Coalescent (Texanol)	6.74
Rheology Modifier - HEUR (Acrysol SCT-275)	15.00
Base - Ammonia (28%)	0.87
Water	308.13

[0124] The resulting prepaint should have a total volume of 100 gallons, a total weight of 1376.04 lbs., a total PVC of 80.00%, a volume solids of 50.00%, a weight solids of 69.54%, a density of 13.76 lbs./gallon, 0.5% dispersant on pigment solids, and 7.00% coalescent on latex solids..

Example 23

[0125] This example describes the preparation of a vinyl acetate/acrylic binder prepaint by combining the following ingredients:

Ingredient	Amount (lbs./100 gallons)
Defoamer	2.00
(Drewplus L-475)	
Binder - Vinyl Acetate/Acrylic (55% solids - Tg 14 °C)	875.62
(RES 3803)	
Coalescent	13.00
(Texanol)	
Rheology Modifier -HEUR	9.29
(Acrysol SCT-275 - Rohm & Haas)	

[0126] The resulting prepaint should have a total volume of 100 gallons, a total weight of 899.91 lbs., a total PVC of 0.00%, a volume solids of 50.00%, a weight solids of 53.52%, a density of 8.99 lbs./gallon, and 10.00% coalescent on latex solids.

Example 24

[0127] This example describes the preparation of a flat acrylic prepaint by combining the following ingredients:

Ingredient	Amount (lbs./100 gallons)
Defoamer	8.00
(Drewplus L-475)	
Binder Acrylic (60.5% solids - Tg 16 °C)	773.67
(Rhoplex AC-264 - Rohm & Haas)	
Coalescent	23.40
(Texanol)	
Rheology Modifier (HEUR)	13
(Acrysol RM-8W - Rohm & Haas)	

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(continued)

Ingredient	Amount (lbs./100 gallons)
Base - Ammonia (28%)	0.50
Solvent - Propylene Glycol	60.00
Water	1.84

[0128] The resulting prepaint should have a total volume of 100 gallons, a total weight of 880.41 lbs., a total PVC of 0.00%, a volume solids of 50.00%, a weight solids of 53.17%, a density of 8.80 lbs./gallon, and 5.00% coalescent on latex solids.

Example 25

[0129] This example describes the preparation of a gloss acrylic binder by combining the following ingredients:

Ingredient	Amount (lbs./100 gallons)
Binder - Acrylic (50% solids - Tg 28°C) (Rhoplex SG-10M - Rohm & Haas)	836.85
Coalescent (Texanol)	41.84

[0130] The resulting prepaint should have a total volume of 100 gallons, a total weight of 878.7 lbs., a total PVC of 0.00%, a volume solids of 44.28%, a weight solids of 47.42%, a density of 8.78 lbs./gallon, and 10.00% coalescent on latex solids.

Example 26

[0131] This example describes the preparation of nine exterior flat latex paints of varying quality and tone using different combinations of the white pigment prepaint of Example 14, the exterior pigment extender prepaint of Example 15, the vinyl acetate-acrylic (PVA) binder prepaint of Example 17, and the flat acrylic binder prepaint of Example 18. The paints are formulated by adding the white pigment prepaint and exterior pigment extender prepaint to the binder prepaints and mixing well.

Paint			Prepaints (wt.)				Water
No.	PVC (%)	Volume Solids (%)	White (Ex 14)	Exterior Extender (Ex 15)	PVA Binder (Ex 17)	Flat Acrylic Binder (Ex 18)	(wt.)
26-1	45.0	35.0	395.53	269.60	—	335.92	104.34
26-2	50.0	30.0	317.19	311.10	—	246.80	208.68
26-3	50.0	30.0	263.69	359.94	197.64	51.38	208.68
26-4	42.5	35.0	197.77	415.12	—	359.92	104.34
26-5	47.5	30.0	158.60	425.86	—	267.37	208.68
26-6	47.5	30.0	131.84	450.28	214.11	55.67	208.68
26-7	40.0	35.0	—	560.64	—	383.91	104.34
26-8	45.0	30.0	—	540.62	—	287.93	208.68
26-9	45.0	30.0	—	540.62	230.58	59.95	208.68

[0132] Paints 26-1, 26-4 and 26-7 are premium quality light, mid and deep tone paints; paints 26-2, 26-5 and 26-8 are first quality light, mid and deep tone paints; and paints 26-3, 26-6 and 26-9 are second quality light, mid and deep tone paints.

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Exempl 27

[0133] This example describes the preparation of nine exterior satin latex paints of varying quality and tone using different combinations of the white pigment prepaint and exterior pigment extender prepaint of Examples 14 and 15, respectively, and the vinyl acetate/acrylic binder (PVA) and flat acrylic binder prepaints of Examples 17 and 18. The paints are formulated as described above.

Paint			Prepaints (wt.)				Water
No.	PVC (%)	Volume Solids (%)	White (Ex 14)	Exterior Extender (Ex 15)	PVA Binder (Ex 17)	Flat Acrylic Binder (Ex 18)	(wt.)
27-1	35.0	35.0	395.53	129.44	—	431.90	104.34
27-2	37.0	30.0	351.59	123.51	—	353.75	208.68
27-3	40.0	26.0	263.69	175.73	228.35	59.41	292.15
27-4	32.5	36.0	197.77	287.98	—	468.92	83.47
27-5	34.5	30.0	175.75	253.98	—	374.31	208.68
27-6	37.5	26.0	131.84	270.07	242.63	63.12	292.12
27-7	30.0	36.0	—	432.50	—	493.60	83.47
27-8	32.0	30.0	—	384.44	—	394.88	208.68
27-9	35.0	26.0	—	364.42	256.87	66.86	292.15

[0134] Paints 27-1, 27-4 and 27-7 are premium quality light, mid and deep tone paints; paints 27-2, 27-5 and 27-8 are first quality light, mid and deep tone paints; and paints 27-3, 27-6 and 27-9 are second quality light, mid and deep tone paints.

Example 28

[0135] This example describes the preparation of nine exterior gloss latex paints of using different combinations of the white pigment and exterior extender prepaints of Examples 14 and 15 and vinyl acetate/acrylic binder (PVA) and gloss acrylic binder prepaints of Examples 17 and 19. The paints are formulated as described above.

Paint			Prepaints (wt.)			Water
No.	PVC (%)	Volume Solids (%)	White (Ex 14)	PVA Binder (Ex 17)	Gloss Acrylic Binder (Ex 19)	(wt.)
28-1	26.0	35.0	435.66	—	494.85	104.34
28-2	30.0	30.0	460.50	—	413.60	166.94
28-3	30.0	30.0	429.93	304.15	88.51	208.68
28-4	13.0	35.0	217.83	—	630.87	104.34
28-5	15.0	30.0	230.25	—	557.38	166.94
28-6	15.0	30.0	214.96	409.14	119.06	208.68
28-7	—	35.0	—	—	766.89	104.34
28-8	—	30.0	—	—	701.15	166.94
28-9	—	30.0	—	514.12	149.61	208.68

[0136] Paints 28-1, 28-4 and 28-7 are premium quality light, mid and deep tone paints; paints 28-2, 28-5 and 28-8 are first quality light, mid and deep tone paints; and paints 28-3, 28-6 and 28-9 are second quality light, mid and deep tone paints.

Example 29

[0137] This example describes the preparation of nine interior flat latex paints using different combinations of the white pigment and interior extender prepaints of Examples 14 and 16 and the vinyl acetate/acrylic (PVA) and flat acrylic binder prepaints of Examples 17 and 18. The paints are formulated as described above.

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Paint			Prepaints (wt.)				Water
No.	PVC (%)	Volume Solids (%)	White (Ex 14)	Interior Extender (Ex 16)	PVA Binder (Ex 17)	Flat Acrylic Binder (Ex 18)	(wt.)
29-1	50.0	30.0	351.59	273.94	197.64	51.38	208.68
29-2	60.0	30.0	263.69	470.21	166.40	—	208.68
29-3	75.0	25.0	128.02	620.95	34.67	—	313.02
29-4	47.5	15.0	175.79	401.73	214.11	55.67	208.68
29-5	57.5	30.0	131.84	558.69	187.20	—	208.68
29-6	72.5	25.0	64.01	653.67	52.00	—	313.02
29-7	45.0	30.0	—	529.51	230.58	59.95	208.68
29-8	55.0	30.0	—	647.18	208.01	—	208.68
29-9	70.0	25.0	—	686.40	69.34	—	313.02

[0138] Paints 29-1, 29-4 and 29-7 are premium quality light, mid and deep tone paints; paints 29-2, 29-5 and 29-8 are first quality light, mid and deep tone paints; and paints 29-3, 29-6 and 29-9 are second quality light, mid and deep tone paints.

Example 30

[0139] This example describes the preparation of nine interior satin latex paints using the white pigment and interior extender prepaints of Examples 14 and 16 and the vinyl acetate/acrylic (PVA) and flat acrylic binder prepaints of Examples 17 and 18. The paints are formulated as described above.

Paint			Prepaints (wt.)				Water
No.	PVC (%)	Volume Solids (%)	White (Ex 14)	Interior Extender (Ex 16)	PVA Binder (Ex 17)	Flat Acrylic Binder (Ex 18)	(wt.)
30-1	35.0	36.0	395.53	140.51	355.75	92.49	83.47
30-2	37.0	30.0	351.59	120.98	357.77	—	208.68
30-3	40.0	20.0	263.69	172.12	288.43	—	292.15
30-4	32.5	36.0	197.77	282.06	375.51	97.96	83.47
30-5	34.5	30.0	175.79	248.76	378.57	—	208.68
30-6	37.5	26.0	131.84	264.52	306.46	—	292.15
30-7	30.0	36.0	—	423.61	395.28	102.77	83.47
30-8	32.0	30.0	—	376.54	399.37	—	208.68
30-9	35.0	26.0	—	356.93	324.49	—	292.15

[0140] Paints 30-1, 30-4 and 30-7 are premium quality light, mid and deep tone paints; paints 30-2, 30-5 and 30-8 are first quality light, mid and deep tone paints; and paints 30-3, 30-6 and 30-9 are second quality light, mid and deep tone paints.

Example 31

[0141] This example describes the preparation of nine interior gloss latex paints using the white pigment prepaint of Example 14 and the vinyl acetate/acrylic (PVA) and gloss acrylic binder prepaints of Examples 17 and 19. The paints are formulated as described above.

Paint			Prepaints (wt.)			Water
No.	PVC (%)	Volume Solids (%)	White (Ex 14)	PVA Binder (Ex 17)	Gloss Acrylic Binder (Ex 19)	(wt.)
31-1	26.0	35.0	435.66	—	494.85	104.34
31-2	30.0	38.0	429.93	304.15	88.51	208.68

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(continued)

Paint			Prepaints (wt.)			Water
No.	PVC (%)	Volume Solids (%)	White (Ex 14)	PVA Binder (Ex 17)	Gloss Acrylic Binder (Ex 19)	(wt.)
31-3	30.1	28.0	403.18	366.31	—	250.42
31-4	13.0	35.0	217.83	—	630.87	104.34
31-5	15.0	30.0	214.96	409.14	119.06	208.68
31-6	15.0	28.0	201.59	493.78	—	250.42
31-7	—	35.0	—	—	766.89	104.34
31-8	—	30.0	—	514.12	149.61	208.68
31-9	—	28.0	—	621.24	—	250.42

[0142] Paints 31-1, 31-4 and 31-7 are premium quality light, mid and deep tone paints; paints 31-2, 31-5 and 31-8 are first quality light, mid and deep tone paints; and paints 31-3, 31-6 and 31-9 are second quality light, mid and deep tone paints.

Example 32

[0143] This example describes the preparation of a latex paint useful for architectural coatings which can be prepared using the white prepaint of Example 20, the exterior pigment extender of Example 21, and the flat acrylic binder prepaint of Example 24. The paint is formulated as described above.

Paint		Prepaints (wt.)			Water
PVC (%)	Volume Solids (%)	White (Ex 20)	Exterior Extender (Ex 21)	Flat Acrylic Binder (Ex 24)	(wt.)
35	48	331.27	294.95	475.42	33.39

[0144] The resulting paint should be a premium paint having a satin finish and a light tone.

Example 33

[0145] This example describes the preparation of a low solids interior flat paint using the white pigment prepaint of Example 20, the interior pigment extender of Example 22, and the vinyl acetate/acrylic (PVA) binder prepaint of Example 23.

Paint		Prepaints (wt.)			Water
PVC (%)	Volume Solids (%)	White (Ex 20)	Interior Extender (Ex 22)	PVA Binder (Ex 23)	(wt.)
75	15	107.22	294.97	16.87	584.31

Example 34

[0146] This example describes the preparation of paints using the prepaints of Examples 1 to 6. The paints were prepared by mixing the pigment prepaint(s) with the binder prepaint(s), then adding the thickeners, water and colorants and mixing well. The Stormer viscosity, ICI viscosity, and pH were the equilibrated measured values.

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Part A — Exterior Flat Paints (Best and Good)								
Prepaint (lbs.)					Thickener (lbs.)			
Paint No.	White Pigment (Ex 1)	Exterior Extender Pigment (Ex 2)	PVA Binder (Ex 4)	Flat Acrylic Binder (Ex 6)	Acrysol SCT- 275	Acrysol RM 2020 NPR	Water (lbs.)	Colorant (lbs.)
34-1 ^a	353.86	278.01	—	306.97	10.40	14.00	149.68	—
34-2 ^b	235.96	351.50	177.30	46.09	26.40	11.20	237.06	—
34-3 ^a	—	516.00	—	351.00	32.68	—	146.45	162
34-4 ^b	—	500.00	206.58	53.70	48.48	—	237.06	162

a. Best light tone and deep tone paints

b. Good light tone and deep tone paints

Measured Equilibrated Values				Calculated Properties					
Paint No.	Stormer Viscosity	ICI Viscosity	pH	Volume A	Weight*	PVC	Volume Solids	Weight Solids	Density
	(KU)	(cp) (gallons)			(lbs)	(%)	(%)	(%)	(b/gal)
34-1 ^c	102	1.15	8.76	100	1112.92	45.05	35.08	50.6 6	11.13
34-2 ^d	101	0.87	8.30	100	1085.52	50.04	30.05	45.6 8	10.86
34-3 ^e	110	1.90	9.02	100	1046.13	39.94	35.00	47.9 2	10.46
34-4 ^f	121	1.80	8.70	100	1045.82	45.09	29.76	43.2 5	10.36

c. There was 0.44% dispersant based on dry pigment and 7.48% coalescent based on dry polymer.

d. There was 0.46% dispersant based on dry pigment and 7.40% coalescent based on dry polymer.

e. There was 0.50% dispersant based on dry pigment and 7.00% coalescent based on dry polymer.

f. There was 0.50% dispersant based on dry pigment and 7.00% coalescent based on dry polymer.

Part B - Exterior Satin Paint (Better)								
Prepaint (lbs.)					Thickener (lbs.)			
Paint No.	White Pigment (Ex 1)	Exterior Extender Pigment (Ex 2)	PVA Binder (Ex 4)	Flat Acrylic Binder (Ex 6)	Acrysol SCT- 275	Acrysol RM 2020 NPR	Water (lbs.)	Colorant (lbs.)
34-5	314.56	137.00	—	323.00	17.82	17.58	234.22	—

Measured Equilibrated Values				Calculated Properties					
Paint No.	Stormer Viscosity	ICI Viscosity	pH	Volume	Weight	PVC	Volume Solids	Weight Solids	Density
	(KU)	(cp)		(gallons)	(lbs)	(%)	(%)	(%)	(b/gal)
34-5	104	1.19	8.95	100.00	1044.18	36.94	29.96	43.26	10.44

[0147] There was 0.43% dispersant based on dry pigment and 7.43% coalescent based on dry polymer.

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Part C — Exterior Semigloss (Best and Good)								
	Prepaint (lbs.)				Thickener (lbs.)			
Paint No.	White Pigment (Ex 1)	Exterior Extender Pigment (Ex 2)	PVA Binder (Ex 4)	Gloss Acrylic Binder (Ex 5)	Acrysol SCT- 275	Acrysol RM 2020 NPR	Water (lbs.)	Colorant (lbs.)
34-6 ^a	389.40	—	—	530.37	—	15.20	98.44	—
34-7 ^b	383.98	—	85.33	294.89	22.40	26.00	217.67	—

a. Best

b. Good

Measured Equilibrated Values				Calculated Properties					
Paint No.	Stormer Viscosity	ICI Viscosity	pH	Volume	Weight	PVC	Volume Solids	Weight Solids	Density
	(KU)	(cp)		(gallons)	(lbs)	(%)	(%)	(%)	(b/gal)
34-6 ^c	99	1.19	8.54	100.00	1033.41	26.00	35.00	46.91	10.33
34-7 ^d	102	1.05	8.20	100.00	1030.27	30.00	29.90	42.43	10.30

c. There was a 0.40% dispersant based on dry pigment solids and a 10.00% coalescent base on dry polymer

d. There was a 0.40% dispersant based on dry pigment solids and a 7.97% coalescent base on dry polymer

Part D - Interior Flat								
	Prepaint (lbs.)				Thickener (lbs.)			
Paint No.	White Pigment (Ex 1)	Interior Extender Pigment (Ex 3)	PVA Binder (Ex 4)	Flat Acrylic Binder (Ex 5)	Acrysol SCT- 275	Acrysol RM 2020 NPR	Water (lbs.)	Colorant (lbs.)
34-8 ^a	314.56	280.69	177.31	46.09	24.00	20.80	230.22	—
34-9	115.95	590.05	30.04	—	34.60	—	336.19	—
34-10 ^a	—	496.07	206.55	53.67	41.92	—	236.60	162
34-11	—	643.99	62.04	—	51.36	—	320.17	162

a. Paints 34-8 and 34-10 were best light and deep tone paints.

Paints 34-9 and 34-11 were good light and deep tone paints.

Measured Equilibrated Values				Calculated Properties					
Paint No.	Stormer Viscosity	ICI Viscosity	pH	Volume	Weight	PVC	Volume Solids	Weight Solids	Density
	(KU)	(cp)		(gallons)	(lbs)	(%)	(%)	(%)	(b/gal)
34-8	99	1.05	8.45	100.00	1093.67	50.00	30.00	45.88	10.94
34-9	84	0.70	8.50	100.00	1106.83	75.15	24.99	43.08	11.07
34-10	120	1.90	8.60	100.00	1034.81	45.04	29.99	43.36	10.35
34-11	108	1.88	8.80	100.00	1077.56	70.00	25.05	41.74	10.78

[0148] The percentage dispersant on dry pigment was 0.45%, 0.48%, 0.50%, and 0.50% for paint nos. 34-8 to 34-11, respectively. The percentages of Coalescent was 7.53%, 47%, 7.00% and 7.00% for paint nos. 34-8 to 34-11, respectively.

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Part E - Interior Satin Paint								
Paint No.	Prepaint (lbs.)				Thickener (lbs.)		Water (lbs.)	Colorant (lbs.)
	White Pigment (Ex 1)	Interior Extender Pigment (Ex 3)	PVA Binder (Ex 4)	Flat Acrylic Binder (Ex 5)	Acrysol SCT- 275	Acrysol RM 2020 NPR		
34-12	314.56	138.00	319.00	—	24.96	21.40	229.76	—

[0149] The paint was a better light tone paint.

Measured Equilibrated Values				Calculated Properties					
Paint No.	Stormer Viscosity	ICI Viscosity	pH	Volume	Weight	PVC	Volume Solids	Weight Solids	Density
	(KU)	(cp)		(gallons)	(lbs)	(%)	(%)	(%)	(b/gal)
34-12	93	0.91	8.37	100.00	1047.68	37.05	29.99	43.54	10.48

[0150] The dispersant in dry pigment was 0.43%.

[0151] The coalescent in dry polymer was 7.42%.

Part F - Semi-Gloss Paint								
Paint No.	Prepaint (lbs.)				Thickener (lbs.)			
	White Pigment (Ex 1)	Interior Extender Pigment (Ex 3)	PVA Binder (Ex 4)	Gloss Acrylic Binder (Ex 6)	Acrysol SCT- 275	Acrysol RM 2020 NPR	Water (lbs.)	Colorant (lbs.)
34-13	383.98	—	294.89	85.33	22.40	26.00	217.67	—
34-14	359.89	—	347.58	—	28.80	28.00	255.70	—

[0152] Paint nos. 34-13 were better and good light tone paints.

Measured Equilibrated Values				Calculated Properties					
Paint No.	Stormer Viscosity	ICI Viscosity	pH	Volume	Weight	PVC	Volume Solids	Weight Solids	Density
	(KU)	(cp)		(gallons)	(lbs)	(%)	(%)	(%)	(b/gal)
34-13	102	1.05	8.20	100.00	1030.27	30.01	29.91	42.43	10.30
34-14	101	1.19	7.90	100.00	1019.97	30.02	28.02	40.22	10.20

[0153] The dispersant was 0.40% on dry pigment for paints 34-13 and 34-14.

[0154] The coalescents were 7.97% and 7.47%, respectively for paints 34-13 and 34-14.

Supplier Information		
Material Name	Material Type	Supplier
Tamol 1124	Dispersant	Rohm and Haas Company (Philadelphia, PA)

(continued)

Supplier Information		
Material Name	Material Type	Supplier
Tamol 1254	Dispersant	Rohm and Haas Company (Philadelphia, PA)
Tamol 731	Dispersant	Rohm and Haas Company (Philadelphia, PA)
Acrysol DR-3	Thickener/Rheology Modifier	Rohm and Haas Company (Philadelphia, PA)
Acrysol RM-2020 NPR	Thickener/Rheology Modifier	Rohm and Haas Company (Philadelphia, PA)
Acrysol RM-8W	Thickener/Rheology Modifier	Rohm and Haas Company (Philadelphia, PA)
Acrysol RM-825	Thickener/Rheology Modifier	Rohm and Haas Company (Philadelphia, PA)
Rhoplex Multilobe 200	Binder	Rohm and Haas Company (Philadelphia, PA)
Rhoplex SG-10M	Binder	Rohm and Haas Company (Philadelphia, PA)
RES 3083	Binder	Rohm and Haas Company (Philadelphia, PA)
Kathon LX 1.5%	Biocide	Rohm and Haas Company (Philadelphia, PA)
Triton CF-10	Surfactant	Union Carbide Corporation (Danbury, CT)
Foamaster VL	Defoamer	Henkel Corporation
Drewplus L-475	Defoamer	Drew Chemical Corporation
Ti-Pure R-746	Titanium Dioxide Slurry	E.I. DuPont de Nemours and Co., Inc. (Wilmington, DE)
Ti-Pure R-706	Titanium Dioxide	E.I. DuPont de Nemours and Co., Inc. (Wilmington, DE)
Ti-Pure R-900	Titanium Dioxide	E.I. DuPont de Nemours and Co., Inc. (Wilmington, DE)
Ti-Pure R-902	Titanium Dioxide	E.I. DuPont de Nemours and Co., Inc. (Wilmington, DE)
Minex 4	Extender	Indusmin, Inc.
Optiwhite	Extender	Burgess Pigment Company
Snowflake	Extender	ECC America, Inc.
Vicron 15-15	Extender	Pfizer
Omyacarb	Extender	Omya
Texanol	Coalescent	Eastman Chemical

[0155] The invention may include data storage and processing devices implemented in digital electronic circuitry, or in computer hardware, firmware, software, or in combinations of them. Aspects of the invention may advantageously be implemented in one or more computer programs that are executable on a programmable system including at least one programmable processor. Suitable processors include, by way of example, both general and special purpose microprocessors. Computers and databases used in the invention can use a variety of data storage devices to store programs, paint formulation information, and other data. These devices include, by way of example, semiconductor memory devices, such as RAM, ROM, EPROM, EEPROM, and flash memory devices; magnetic disks such as internal hard disks and removable disks; magneto-optical disks; and CD-ROM disks. Any of the foregoing may be supplemented by, or incorporated in, specially-designed ASICs (application-specific integrated circuits).

[0156] A number of embodiments of the present invention have been described. Nevertheless, it will be understood that various modifications may be made without departing from the spirit and scope of the invention. Accordingly, other embodiments are within the scope of the following claims.

Claims

1. A paint manufacturing method comprising:

receiving each of a plurality of fluid prepaits at different ones of a plurality of inputs of a fluid component mixing system;
determining at a computer system a first fluid prepaits ratio comprising a ratio to produce a first base paint selected from a plurality of base paints types that can be formulated from the plurality of fluid prepaits; and
mixing the plurality of fluid prepaits in accordance with the first ratio to form at an output of the mixing system the first base paint.

2. The method of claim 1 further comprising tinting the first base paint to form a first colored paint.

3. The method of claim 1 further comprising:

determining a second fluid prepaits ratio comprising a ratio to produce a second base paint selected from the plurality of base paints types; and
mixing the plurality of fluid prepaits in accordance with the second ratio to form at an output of the mixing system the second base paint.

4. The method of claim 3 wherein the first and second base paints have different sheen level application characteristics, the sheen level characteristics being selected from the group consisting of a flat sheen, a satin sheen, a semi-gloss sheen, and a gloss sheen.

5. The method of claim 1 wherein the mixing system comprises a in-line mixing system and mixing in accordance with the first ratio comprises continuously flowing the fluid prepaits from the inputs to the output of the mixing system in accordance with the first ratio.

6. The method of claim 1 wherein mixing to form the first base paint comprises mixing without the addition of non-fluid components.

7. The method of claim 1 wherein mixing further comprises adding water.

8. The method of claim 1 wherein mixing comprises:

receiving at the computer system sensor data indicating a volume of each of the plurality of fluid prepaits entering the mixing system; and
sending a signal from the computer system to the mixing system to dynamically adjust a flow of each of the fluid prepaits based on the received sensor data.

9. The method of claim 8 wherein the computer system comprises a distributed computer system comprising multiple processing servers and database computers.

10. The method of claim 8 wherein:
dynamically adjusting the flow comprises adjusting the flow of each prepaits to maintain at the first ratio the prepaits entering the mixing system.

11. The method of claim 10 wherein:

the mixing system further comprises a plurality of electrically adjustable valves each configured to regulate a flow entering a different mixing system input; and
sending a signal to the mixing system comprises sending signals individually controlling each of the plurality of valves.

12. The method of claim 1 further comprising:

receiving at the computer system a first customer order comprising a first paint quantity and a first paint type identifier; and

determining at the computer system the first ratio based on the first paint type identifier.

13. The method of claim 12 wherein mixing comprises continuously mixing under control of the computer system to form a volume of the first base paint substantially equal to the first paint quantity.

14. The method of claim 12 wherein receiving the first customer order comprises receiving from a web client terminal and wherein mixing comprises mixing at a point-of-sale retail location in response to the first customer order.

15. The method of claim 14 wherein the first customer order further comprises a payment identifier and the method further comprises exchanging data comprising the payment identifier with a payment processing system.

16. The method of claim 15 wherein the payment identifier comprises an identifier selected from the group consisting of a consumer credit card number, a consumer debit card number, and a checking account identifier.

17. A paint manufacturing system comprising:

a prepaint mixing system comprising a plurality of fluid inputs, each fluid input comprising a computer-controllable fluid flow control; and
a computer system operatively coupled to each fluid flow control, the computer system comprising a memory storing software instructions to configure the computer system to:

receive user input selecting a first one of a plurality of base paint types,
determine a first ratio of fluid prepaints associated with the first base paint type, and
regulate each fluid flow control to establish in the determined ratio a flow of fluid prepaints entering the fluid mixing system.

18. The system of claim 17 wherein the computer system comprises multiple separate processors interconnected by a data network.

19. The system of claim 17 further comprising a database comprising data associating each of a plurality of different base paint types with a ratio of fluid prepaints.

20. The system of claim 19 wherein the instructions to determine the ratio of fluid prepaints comprise instructions to query the database to retrieve the ratio.

21. The system of claim 19 wherein the database comprises data selected from the group consisting of:

an algorithm comprising stored instructions executable by the computer system, and
stored associations between a plurality of base paint types and predetermined ratios of fluid prepaints.

22. The system of claim 19 wherein each fluid flow control comprises a valve operatively coupled to the computer system.

23. The system of claim 22 wherein operatively coupled comprises coupled by a pneumatic controller.

24. A paint manufacturing system comprising:

a plurality of paint manufacturing sites each operable to produce a paint product and each comprising a site control computer comprising instructions to control a paint manufacturing process; and
a coordinating computer system operatively coupled to each of the plant control computers by a network, the coordinating computer system comprising stored software instructions to configure the coordinating computer to exchange manufacturing operations data with the plurality of site control computers.

25. The system of claim 24 wherein the instructions to control a paint manufacturing process comprise instructions to control a ratio of manufacturing ingredients in a paint product produced at a paint manufacturing site.

26. The system of claim 24 wherein the instructions to exchange manufacturing operations data comprise instructions to receive paint manufacturing supply data from each of the plurality of paint manufacturing sites, and the coordi-

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nating computer system further comprises instructions to automatically schedule a supply delivery based on the received supply data.

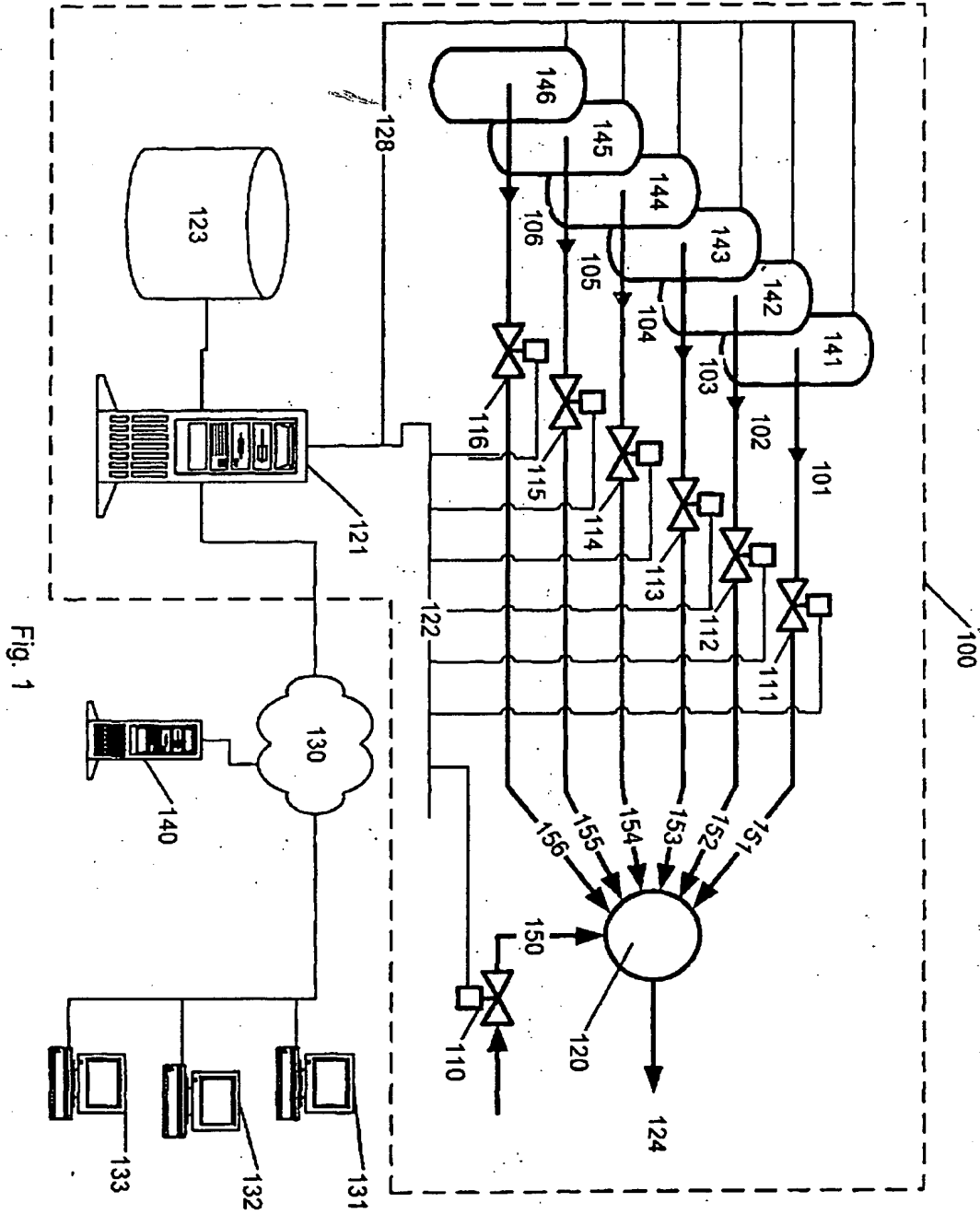
5 27. The system of claim 24 wherein each of the plurality of paint manufacturing sites comprise a fluid mixing system configured to produce a base paint from a plurality of fluid prepaints and water.

28. The system of claim 24 wherein:

10 the coordinating computer system is further configured to receive customer order data from client computers;
and
the instructions to exchange manufacturing operations data comprise instructions to process received customer order data and route the customer order data to one of the plurality of paint manufacturing sites.

15 29. The system of claim 28 wherein the instructions to route the customer order data comprise instructions to route based on site capacity data received at the coordinating computer system from the plurality of paint manufacturing sites.

20 30. The system of claim 24 wherein each paint manufacturing site comprises a manufacturing site configured for small-batch point-of-sale operation.



What type of paint would you like?

Select Sheen Level 211

Select Tint Level 213

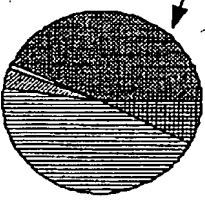
Select Use Type 214


Select Quality Level 215

Select Volume Needed 216

Make Paint Extra Thick? ☒ Check for Extra Thick Paint 215

Paint Volumes

220  230

212  240

250 Total: \$ 32.82

251 Place Order

Paint Volumes Legend:

- PP1 TiO2
- PP2 Ext
- PP3 Int
- PP4 PVA
- PP5 FltA
- PP6 GlcA
- Thickener
- Water

Fig. 2

Volumes of Prepaints										RMC *	
										Markup =	
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DB	Paint	Shreen	Tint	Use Type	Quality	PP1 Vol	PP2 Vol	PP3 Vol	PP4 Vol	PP5 Vol	PP6 Vol	Water Vol	Base Price
Code	ID	Level	Base	Type	Level								
1422	23	Gloss	Deep	Interior	Improved	0.00%	0.00%	0.00%	51.49%	0.00%	17.51%	31.00%	\$ 7.51
1423	24	Gloss	Deep	Interior	Basic	0.00%	0.00%	0.00%	62.22%	0.00%	0.00%	37.78%	\$ 5.43
2111	25	emiGloss	White	Exterior	Premium	25.87%	4.85%	0.00%	0.00%	0.00%	54.97%	14.32%	\$ 20.29
2112	26	emiGloss	White	Exterior	Improved	27.34%	4.35%	0.00%	0.00%	0.00%	46.15%	22.13%	\$ 19.34
2113	27	emiGloss	White	Exterior	Basic	25.53%	4.21%	0.00%	28.97%	0.00%	9.85%	31.45%	\$ 14.87
2121	28	emiGloss	White	Interior	Premium	25.87%	0.00%	4.85%	0.00%	0.00%	54.97%	14.32%	\$ 20.34
2122	29	emiGloss	White	Interior	Improved	25.53%	0.00%	4.21%	28.97%	0.00%	9.85%	31.45%	\$ 14.91
2123	30	emiGloss	White	Interior	Basic	23.94%	0.00%	3.82%	35.00%	0.00%	0.00%	37.25%	\$ 13.06
2211	31	emiGloss	Light	Exterior	Premium	23.60%	7.07%	0.00%	0.00%	0.00%	54.97%	14.37%	\$ 19.50
2212	32	emiGloss	Light	Exterior	Improved	25.07%	6.60%	0.00%	0.00%	0.00%	46.15%	22.18%	\$ 18.55
2213	33	emiGloss	Light	Exterior	Basic	23.26%	6.43%	0.00%	28.97%	0.00%	9.85%	31.50%	\$ 14.07
2221	34	emiGloss	Light	Interior	Premium	23.60%	0.00%	7.07%	0.00%	0.00%	54.97%	14.37%	\$ 19.57
2222	35	emiGloss	Light	Interior	Improved	23.26%	0.00%	6.43%	28.97%	0.00%	9.85%	31.50%	\$ 14.13
2223	36	emiGloss	Light	Interior	Basic	21.67%	0.00%	6.04%	35.00%	0.00%	0.00%	37.30%	\$ 12.29
2311	37	emiGloss	Mid	Exterior	Premium	12.93%	4.85%	0.00%	0.00%	0.00%	69.55%	12.66%	\$ 17.54
2312	38	emiGloss	Mid	Exterior	Improved	13.67%	4.41%	0.00%	0.00%	0.00%	61.54%	20.38%	\$ 16.43
2313	39	emiGloss	Mid	Exterior	Basic	12.76%	4.19%	0.00%	38.62%	0.00%	13.13%	31.30%	\$ 11.08
2321	40	emiGloss	Mid	Interior	Premium	12.93%	0.00%	4.85%	0.00%	0.00%	69.55%	12.66%	\$ 17.59
2322	41	emiGloss	Mid	Interior	Improved	12.76%	0.00%	4.19%	38.62%	0.00%	13.13%	31.30%	\$ 11.12
2323	42	emiGloss	Mid	Interior	Basic	11.97%	0.00%	3.85%	46.67%	0.00%	0.00%	37.51%	\$ 9.21
2411	43	emiGloss	Deep	Exterior	Premium	0.00%	4.86%	0.00%	0.00%	0.00%	84.13%	11.00%	\$ 14.79
2412	44	emiGloss	Deep	Exterior	Improved	0.00%	4.44%	0.00%	0.00%	0.00%	76.92%	18.63%	\$ 13.52
2413	45	emiGloss	Deep	Exterior	Basic	0.00%	4.17%	0.00%	48.28%	0.00%	16.41%	31.14%	\$ 7.29
2421	46	emiGloss	Deep	Interior	Premium	0.00%	0.00%	4.86%	0.00%	0.00%	84.13%	11.00%	\$ 14.83
2422	47	emiGloss	Deep	Interior	Improved	0.00%	0.00%	4.17%	48.28%	0.00%	16.41%	31.14%	\$ 7.33
2423	48	emiGloss	Deep	Interior	Basic	0.00%	0.00%	3.89%	58.33%	0.00%	0.00%	37.78%	\$ 5.36
3111	49	Satin	White	Exterior	Premium	23.48%	12.04%	0.00%	0.00%	46.02%	0.00%	18.46%	\$ 18.09
3112	50	Satin	White	Exterior	Improved	20.87%	10.42%	0.00%	0.00%	36.65%	0.00%	32.06%	\$ 15.34
3113	51	Satin	White	Exterior	Basic	15.66%	13.58%	0.00%	22.87%	6.15%	0.00%	41.74%	\$ 10.22
3121	52	Satin	White	Interior	Premium	23.48%	0.00%	12.04%	35.63%	9.58%	0.00%	19.27%	\$ 15.12
3122	53	Satin	White	Interior	Improved	20.87%	0.00%	10.42%	35.83%	0.00%	0.00%	32.87%	\$ 12.34

Fig. 3B

DB	Paint	Sheen	Tint	Use Type	Quality	PP1 Vol	PP2 Vol	PP3 Vol	PP4 Vol	PP5 Vol	PP6 Vol	Water Vol	Base Price
Code	ID	Level	Base		Level								
3123	54	Satin	White	Interior	Basic	15.66%	0.00%	13.58%	28.89%	0.00%	0.00%	41.87%	\$ 9.83
3211	55	Satin	Light	Exterior	Premium	21.21%	14.26%	0.00%	0.00%	46.02%	0.00%	18.51%	\$ 17.30
3212	56	Satin	Light	Exterior	Improved	18.61%	12.64%	0.00%	0.00%	36.65%	0.00%	32.11%	\$ 14.55
3213	57	Satin	Light	Exterior	Basic	13.39%	15.80%	0.00%	22.87%	6.15%	0.00%	41.79%	\$ 9.42
3221	58	Satin	Light	Interior	Premium	21.21%	0.00%	14.26%	35.63%	9.58%	0.00%	19.32%	\$ 14.35
3222	59	Satin	Light	Interior	Improved	18.61%	0.00%	12.64%	35.83%	0.00%	0.00%	32.92%	\$ 11.57
3223	60	Satin	Light	Interior	Basic	13.39%	0.00%	15.80%	28.89%	0.00%	0.00%	41.92%	\$ 9.06
3311	61	Satin	Mid	Exterior	Premium	11.74%	21.02%	0.00%	0.00%	48.58%	0.00%	18.66%	\$ 14.27
3312	62	Satin	Mid	Exterior	Improved	10.44%	18.54%	0.00%	0.00%	38.78%	0.00%	32.24%	\$ 11.93
3313	63	Satin	Mid	Exterior	Basic	7.83%	19.43%	0.00%	24.30%	6.54%	0.00%	41.90%	\$ 7.56
3321	64	Satin	Mid	Interior	Premium	11.74%	0.00%	21.02%	37.61%	10.11%	0.00%	19.51%	\$ 11.22
3322	65	Satin	Mid	Interior	Improved	10.44%	0.00%	18.54%	37.92%	0.00%	0.00%	33.10%	\$ 8.83
3323	66	Satin	Mid	Interior	Basic	7.83%	0.00%	19.43%	30.69%	0.00%	0.00%	42.05%	\$ 7.20
3411	67	Satin	Deep	Exterior	Premium	0.00%	30.00%	0.00%	0.00%	51.14%	0.00%	18.86%	\$ 10.46
3412	68	Satin	Deep	Exterior	Improved	0.00%	26.67%	0.00%	0.00%	40.91%	0.00%	32.42%	\$ 8.52
3413	69	Satin	Deep	Exterior	Basic	0.00%	25.28%	0.00%	25.73%	8.83%	0.00%	42.07%	\$ 4.91
3421	70	Satin	Deep	Interior	Premium	0.00%	0.00%	30.00%	39.59%	10.65%	0.00%	19.76%	\$ 7.32
3422	71	Satin	Deep	Interior	Improved	0.00%	0.00%	26.67%	40.00%	0.00%	0.00%	33.33%	\$ 5.32
3423	72	Satin	Deep	Interior	Basic	0.00%	0.00%	25.28%	32.50%	0.00%	0.00%	42.22%	\$ 4.57
4111	73	Flat	White	Exterior	Premium	23.48%	20.79%	0.00%	0.00%	34.80%	0.00%	20.93%	\$ 16.70
4112	74	Flat	White	Exterior	Improved	18.83%	23.25%	0.00%	0.00%	25.57%	0.00%	32.35%	\$ 13.38
4113	75	Flat	White	Exterior	Basic	15.66%	26.36%	0.00%	19.80%	5.32%	0.00%	32.87%	\$ 10.56
4121	76	Flat	White	Interior	Premium	20.87%	0.00%	21.26%	19.80%	5.32%	0.00%	32.75%	\$ 12.59
4122	77	Flat	White	Interior	Improved	15.66%	0.00%	34.69%	16.67%	0.00%	0.00%	32.99%	\$ 10.21
4123	78	Flat	White	Interior	Basic	7.60%	0.00%	44.65%	3.47%	0.00%	0.00%	44.28%	\$ 6.46
4211	79	Flat	Light	Exterior	Premium	22.35%	21.90%	0.00%	0.00%	34.80%	0.00%	20.95%	\$ 16.30
4212	80	Flat	Light	Exterior	Improved	16.56%	25.47%	0.00%	0.00%	25.57%	0.00%	32.40%	\$ 12.59
4213	81	Flat	Light	Exterior	Basic	13.39%	28.58%	0.00%	19.80%	5.32%	0.00%	32.92%	\$ 9.77
4221	82	Flat	Light	Interior	Premium	18.61%	0.00%	23.47%	19.80%	5.32%	0.00%	32.80%	\$ 11.82
4222	83	Flat	Light	Interior	Improved	13.39%	0.00%	36.91%	16.67%	0.00%	0.00%	33.04%	\$ 9.44
4223	84	Flat	Light	Interior	Basic	5.33%	0.00%	46.87%	3.47%	0.00%	0.00%	44.33%	\$ 5.69

Fig. 3C

<u>DB</u>	<u>Paint</u>	<u>Sheen</u>	<u>Tint</u>	<u>Use Type</u>	<u>Quality</u>	<u>PP1 Vol</u>	<u>PP2 Vol</u>	<u>PP3 Vol</u>	<u>PP4 Vol</u>	<u>PP5 Vol</u>	<u>PP6 Vol</u>	<u>Water Vol</u>	<u>Base</u>
<u>Code</u>	<u>ID</u>	<u>Level</u>	<u>Base</u>	<u>Use Type</u>	<u>Level</u>								<u>Price</u>
4311	85	Flat	Mid	Exterior	Premium	11.74%	29.84%	0.00%	0.00%	37.29%	0.00%	21.13%	\$ 12.88
4312	86	Flat	Mid	Exterior	Improved	9.42%	30.38%	0.00%	0.00%	27.70%	0.00%	32.51%	\$ 10.33
4313	87	Flat	Mid	Exterior	Basic	7.83%	31.93%	0.00%	21.44%	5.77%	0.00%	33.03%	\$ 7.92
4321	88	Flat	Mid	Interior	Premium	10.44%	0.00%	29.38%	21.44%	5.77%	0.00%	32.97%	\$ 9.12
4322	89	Flat	Mid	Interior	Improved	7.83%	0.00%	40.26%	18.75%	0.00%	0.00%	33.16%	\$ 7.59
4323	90	Flat	Mid	Interior	Basic	3.80%	0.00%	46.63%	5.21%	0.00%	0.00%	44.36%	\$ 5.20
4411	91	Flat	Deep	Exterior	Premium	0.00%	38.89%	0.00%	0.00%	39.77%	0.00%	21.34%	\$ 9.05
4412	92	Flat	Deep	Exterior	Improved	0.00%	37.50%	0.00%	0.00%	29.83%	0.00%	32.67%	\$ 7.28
4413	93	Flat	Deep	Exterior	Basic	0.00%	37.50%	0.00%	23.09%	6.21%	0.00%	33.20%	\$ 5.28
4421	94	Flat	Deep	Interior	Premium	0.00%	0.00%	37.50%	23.09%	6.21%	0.00%	33.20%	\$ 5.64
4422	95	Flat	Deep	Interior	Improved	0.00%	0.00%	45.83%	20.83%	0.00%	0.00%	33.33%	\$ 4.96
4423	96	Flat	Deep	Interior	Basic	0.00%	0.00%	48.61%	6.94%	0.00%	0.00%	44.44%	\$ 3.94

Fig. 3D

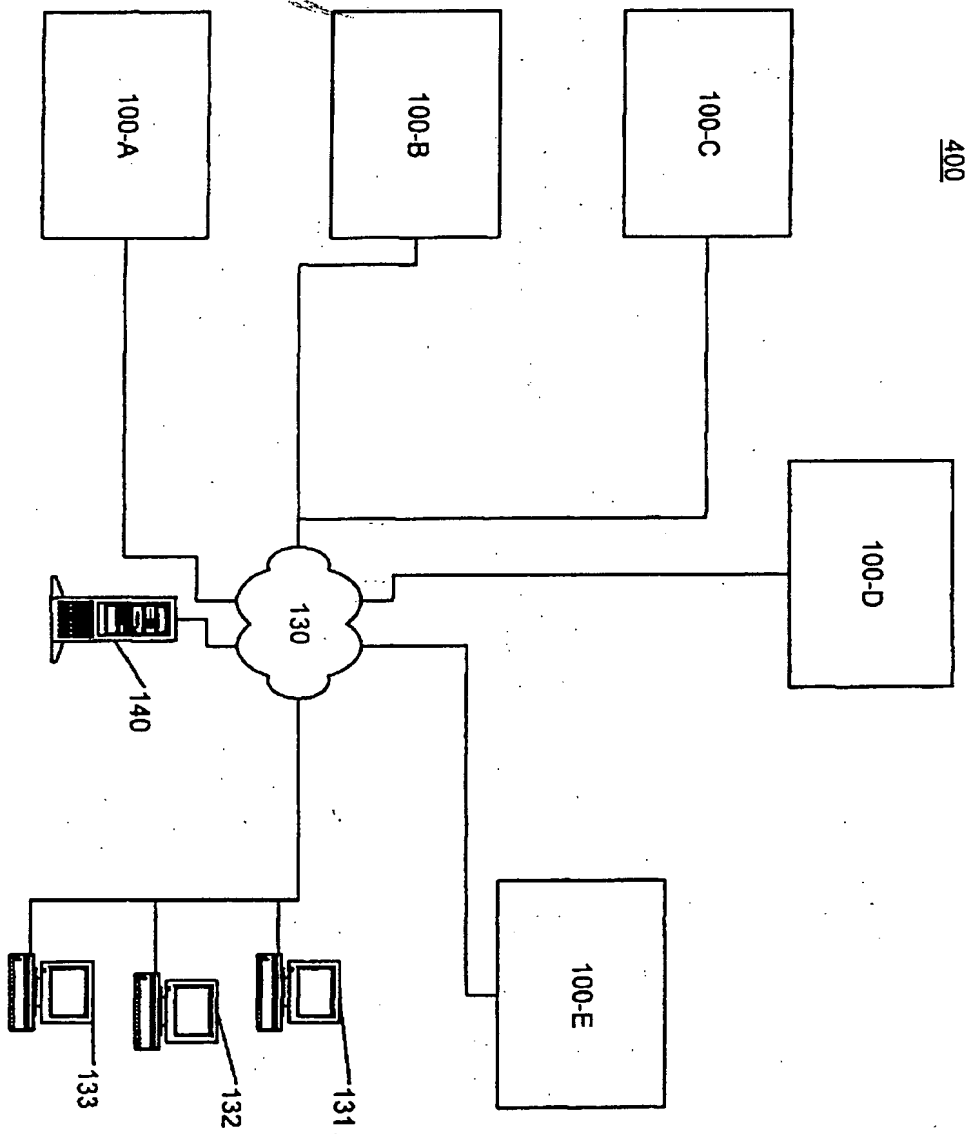


Fig. 4